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现代应用光学

斯托克斯椭偏仪的非线性最小二乘拟合偏振定标

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摘要： 由于传统的斯托克斯椭偏仪定标方法中入射光源的偏振效应、定标单元中光学元件的制造与装调误差都会降低仪器矩阵的定标精度，从而影响偏振态的测量精度，本文提出了基于非线性最小二乘拟合算法的仪器矩阵偏振定标方法。该方法将描述定标单元的参量和仪器矩阵的所有矩阵元一起作为未知参数，根据偏振光学传输理论建立探测光强与未知参数的函数关系式；然后,基于非线性最小二乘拟合方法拟合实际探测光强随定标单元方位角的变化曲线，进而得到斯托克斯椭偏仪的仪器矩阵。实验中使用该方法和传统方法在500~700 nm波段分别定标了KD*P型斯托克斯椭偏仪的仪器矩阵。结果显示，新方法在500~600 nm波段获得的斯托克斯参数的总均方根(RMS)偏差为1.6%，较传统定标方法提高约0.5%；波长大于600 nm时，由于系统信噪比降低使得新方法的测量精度降为2.4%，但仍然远高于传统方法的测量精度。结果表明，提出的方法简单易行，适用于各种斯托克斯椭偏仪的仪器矩阵定标。

关键词： 太阳望远镜 斯托克斯椭偏仪 偏振定标 非线性最小二乘拟合 仪器矩阵

Nonlinear Least-Squares Fitting Polarization Calibration of Stokes Ellipsometer

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Abstract: Traditional calibration methods for a Stokes ellipsometer will reduce the calibration accuracy of instrument matrix and effect the measuring accuracy of a polarization state, due to the polarization effect of incident light and the imperfect optical elements in a calibration unit. To measure precisely the instrument matrix of the Stokes ellipsometer, a calibration method was proposed based on the nonlinear least-square fitting method. By taking error sources mentioned above and instrument matrix together as unknown parameters, the function formula between detector intensity and unknown parameters was established based on the Mueller matrix theory. Then nonlinear least-square fitting method was used to fit the detecting intensity curves changed with the azimuth of calibration units and to calculate the instrument matrix of Stokes ellipsometer. The new method and traditional methods were used to calibrate the instrument matrix at 500-700 nm, and it is shown that the total Root Mean Square (RMS) of the Stokes parameter by the proposed method is 1.6% in 500-600 nm, about 0.5% less than that of traditional methods. Moreover, when wavelength is larger than 600 nm, the RMS drops to 2.4%, but it still is far less than that of traditional methods. In conclusions, the method is easily feasible and is suitable for the calibration of instrument matrix for various Stokes ellipsometers.

Keywords: Solar telescope Stokes ellipsometer Polarization calibration Nonlinear least-squares fitting Instrument matrix

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