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微球测速聚类分析的流式液路稳定性评估

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Stability evaluation of flow cytometer liquid path based on cluster analysis of particle velocity

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摘要 提出了一种基于90° Mie散射的高速图像采集微球测速方法,用于准确评估流式细胞仪流动室内的层流状态及单细胞流的稳定性。利用流动室内微球速度的稳定性对流动室内单细胞流的稳定性进行了评估。首先,利用高速显微成像系统采集90° Mie散射光的图像,选取90°侧向散射光以避免激发光源直射光的干扰,同时去除背景光源并提高图像对比度;然后,利用基于梯形白化权函数的灰色聚类分析方法对微球拖尾图像进行分类,实现对不足、正常、衍射和重叠4种情况的准确分类;最后,利用中点法确定正常图像上升沿及下降沿的边界,提高拖尾长度计算的准确性。搭建了高速微球测速实验系统,对本文方法进行验证。结果表明,该方法能够获得清晰的微球拖尾图像并对微球拖尾图像进行准确分类。对本文实验系统测得的微球拖尾长度平均值为116.9个像素点,标准差为1.7。

关键词 : 流式细胞仪, 液路稳定性评估, 微球测速, 高速图像采集, 聚类分析

Abstract : A high-speed particle image velocimetry based on 90° Mie scattering was proposed to evaluate the status of laminar flow and single-cell flow stability in the flow cell of a flow cytometer. The velocity stability of the particles in the flow cell was used to evaluate the single-cell flow stability of the flow cytometer. Firstly, 90° Mie scattering images of the particle were acquired with a high-speed image sampling system. The 90° Mie scattering selected could avoid the interference of the excitation light source and could remove the background source and improve the image contrast. Then, the grey cluster analysis algorithm based on trapezoid whitenization weight functions was used to classify for all different types of images with shortages, normal, diffraction and overlap. Finally, a center-point method was taken to determine the boundaries of the trailing image to improve the computational accuracy of the length of particle trailing. A experimental system was carried out to verify the feasibility of the comprehensive method. The results show that the method obtains distinct trailing images and they have been classified accurately. Moreover, for the system of this article, the average length of trailing image covers 116.9 pixels, and the standard deviation is 1.7.

Key words : flow cytometer flow stability evaluation particle velocity measurement high-speed image sampling cluster analysis

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