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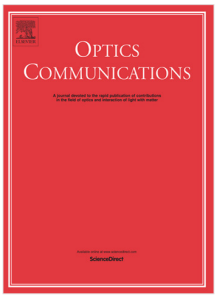

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Filtering-Tikhonov Regularization Inversion for Dynamic Light Scattering Data with Strong Noise

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Abstract: The Tikhonov regularization is an effective method used for dynamic light scattering (DLS) data inversion. However, its inversion accuracy is low for the strong noise data. Based on filtering and Tikhonov regularization technology, we propose a filter-Tikhonov-L method. To begin with, this method uses the cubical smoothing algorithm with five-point approximation to filter out the noise of autocorrelation function (ACF). A new inversion problem is constructed by the filtered ACF, and then solved by Tikhonov regularization with L-curve criterion. This method combines the advantages of filtering and Tikhonov regularization technology, so that it has the high inversion accuracy. The simulation data of particles with particle size distribution (PSD) from 100nm to 700nm was implemented inversion studies. The investigation shows that filter-Tikhonov-L has a great advantage in peak position, relative error, the capability of recognizing double peaks and tolerance of noises. The inversion of experimental data also verifies this conclusion.

Keywords: dynamic light scattering; regularization; particle size inversion; filtering
OCIS Codes: 120.4640；120.5820；290. 5850;

1. Introduction

DLS technology is a popular method used to measure PSD of ultrafine particles in suspension.This technology can recover PSD by ACF of scattering light intensity [1-3]. However, PSD inversion is ill-posed problem, which is an inherently difficult problem due to the solution of Fredholm integral equation of the first kind. When there is non noise in the data and non calculation error in the solution of the equation, the equation has a unique solution. Due to the effect of the noise and calculation error in the practical measurements, it is difficult to get the true solution of the equation. In order to deal with this problem, a variety of inversion algorithms have been put forward to estimate the PSD from DLS data, such as CONTIN method [4], the maximum likelihood method [5], Tikhonov regularization method [6], the non-negative constraint TSVD method [7], double exponential method[8], NNLS method[9]. These algorithms have the different characteristics in the application. Among them, Tikhonov regularization is a popular method to solve the ill-posed problem [10-12], which can achieve a better inversion results for the data of the usual noise level. According to the literature [13], the noise level of the measured data is generally about 0.001, or even lower. In some practical applications [14-16], the noise level of DLS data is sometimes higher than usual situations. In this case, ACF has violent fluctuations and its smoothness is poor. For the inversion of this kind of data, the traditional Tikhonov regularization is difficult to obtain satisfactory results. To some extent, the tolerance of noises of this method can improve by

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