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Analysis of particle streaks

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For particles in turbulent wall bounded flow, it has been found that the particles tend to agglomerate in streamwise streaks close to the wall for certain flow situations. The analysis and quantification of these streaks are not straightforward and methods need to be developed. Both the width of these streaks, and a measure of the streakiness are wanted.

In this study, a method based on correlation analysis is suggested. The method uses the location of each particle in an image, and assigns each particle the same width in the spanwise direction, in order to get high enough energy in the signal. Thereafter, each individual image is summed in the streamwise direction, and an intensity signal is obtained. Figure 1(a) shows two signals for images from two different cases. When autocorrelating each signal, with the mean subtracted, a measure the mean streak-width is found as displacement at which the minimum correlation occurs. The value of the minimum correlation is a measure of how coherent the structures in the flow are.

This in turn should also provide a quantification of the streakiness. However, this is not the case. The two signals in figure 1(a), results in the same value of the minimum correlation. However, when investigating the images by eye, it is evident that the structures in the two cases are of different strength. To achieve a way to quantify the streakiness, several methods have been evaluated. One of the more promising, being a Voronoi analysis, where the *rms* of the summed Voronoi diagram is evaluated. Common for all methods is that the effect of concentration on the correlation is found to be severe. In short, the number of particles in each image effects the minimum correlation. This is also verified in experiments from the same flow with different (very dilute) concentrations.

The concentration effect can also be studied by random removal of particles in the post-processing of images. This way, one can determine the minimum value of the correlation at different concentration levels artificially, see figure 1(b). The minimum correlation increases as particles are removed (the number of particles in each image decreases) and the decrease is seen to be logarithmic. Streakiness measures from experiments at different concentrations can now be compared by interpolation.

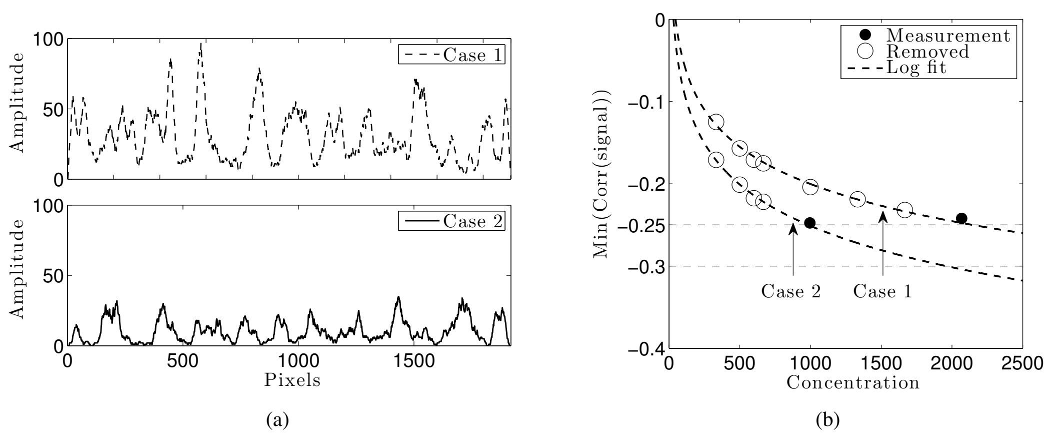

Figure 1: (a) Intensity signal for two images, summed in the direction of the streaks. (b) Correlation minima, where particles have been removed to reach different concentrations.