# Trend Technology's Theory Model and Experiment Verification for Atmospheric Optical Scintillation

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**Abstract**— Trend technology's theoretical model for atmospheric optical scintillation is establishes in this paper. For many years, people have always thought that atmospheric optics is completely random. In the previous paper, the author has used several experiments to overturn the traditional view. In this paper, the author will put forward a model to explain the author's point of view theoretically. It will demonstrate the process how does the optical scintillation evolve according to the trend. In this paper, the author will give the second batch of the experimental data to verify the theory model.

## 1. INTRODUCTION

When laser is transmitted through atmospheric turbulence, because of the influence of temperature, pressure, wind speed and other factors, the optical wavefront distorts. The light intensity varies. It is called as scintillation. For many years, scientific communities have made efforts in this field [1, 2]. Almost all of the experiments concern only with changes between one or two data points. The changes reflect a completely random shape.

In the field of atmospheric optics, adaptive optics (AO) system is usually used to correct wavefront [3]. For example, in an optical imaging system, firstly a beam is transmitted along the path. Then the wavefront distortion resulting from atmospheric turbulence is measured. A conjugation shape of wavefront distortion is produced on the deformable mirror to compensate the wavefront. Finally a clear picture can be seen at the image terminal. Because the traditional view treats the atmospheric turbulence is totally random, AO system is designed to passively follow the wavefront variation. When optical scintillation is strong, AO system usually fails to keep pace with the change of the turbulence. At this time, AO system is paralysed.

However, in a preceding study, the author discovered that optical scintillation is not completely random [4]. The author has used experimental data from three different links to prove it. This actually provides us with a new method for AO wavefront correction. In other words, it means to predict scintillation according to the previous turbulent trend.

In the second part of this paper, the author will establish a model to demonstrate how does scintillation evolve with the trend. In the third part, the author will continue to disclose the second batch of experimental data to support this model.

## 2. MODEL OF OPTICAL SCINTILLATION EVOLVES WITH TREND

Suppose that there is a laser beam fleets across a four-quadrant detector along the positive $X$ axis. As shown in Figure 1, they are 4 consecutive frames of sampled data. The intensities in the 1st and 4th quadrants are more and more strong, and intensities in the 2 and the 3 quadrants are more and more weak. Use the time (frame number) as the horizontal axis. Use the total intensity in every quadrant as the vertical axis. Plot the pictures for every quadrants. We can observe signal patterns as shown in Figure 2.

If we lessen the observation time scale, considering the randomness of turbulence, actually we will observe the similar signal behaviors as shown in Figure 3. The signals move along large-scale trends. At the same time, it displays small-scale fluctuations.

Thus, we can observe the four quadrants of data as a whole. Estimate the signals' running trend. According to the running trend of signals,we can predict in the next few frames how does the signals will run.

## 3. THE SECOND BATCH OF EXPERIMENTAL DATA

In [4], the author introduced 3 kinds of different optical propagation experimental links. In the three links, image is sampled by a high speed camera. One frame of received optical pattern is shown in Figure 4. The receiving aperture is made up of a number of sub-aperture. Colorful values at its right side are used to evaluate the strength of the optical intensities.

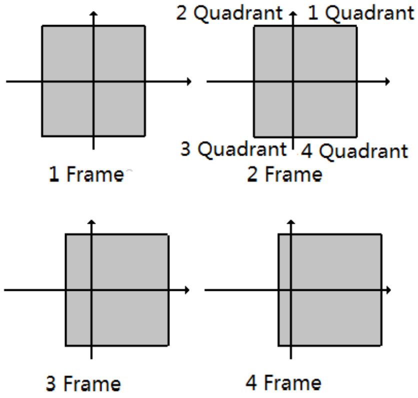

Figure 1: Four frames of data.

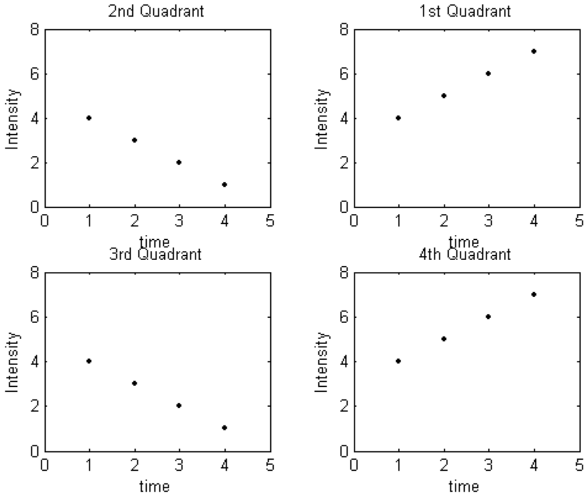

Figure 2: Total intensities of every quadrant.

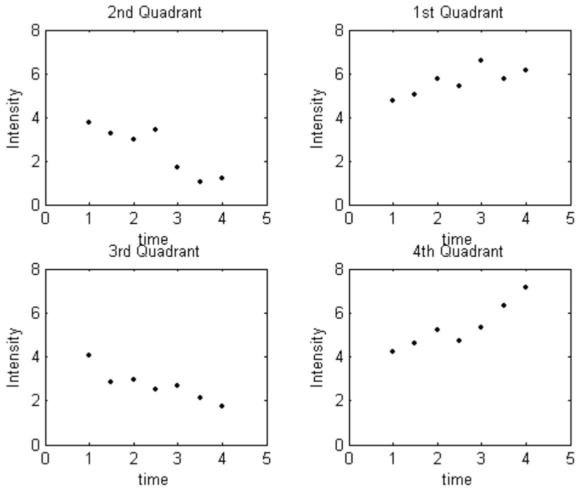

Figure 3: Signal behaviors when considering small-period random fluctuations.

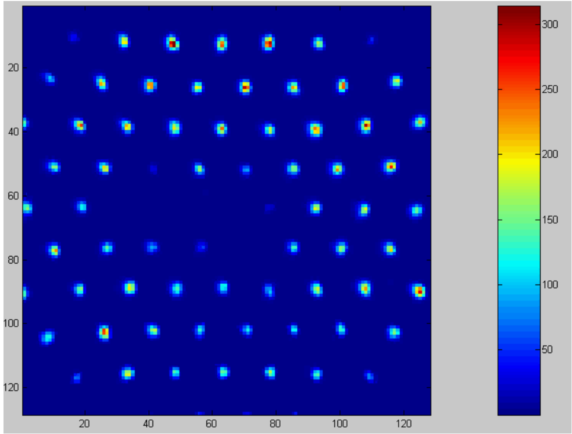

Figure 4: Speckle pattern of sub-apertures.

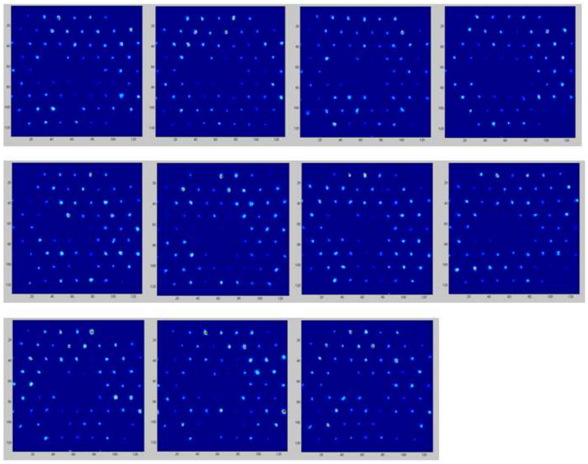

Figure 5: 11 frames of continuous images in an active laser illumination experiment.

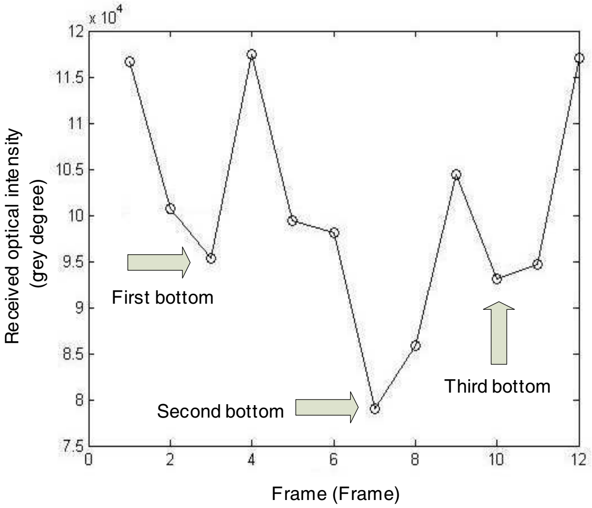

Figure 6: Processed data of Figure 5.

### 3.1. Active Laser Illumination Experiment

One of the active laser illumination experimental data is shown in Figure 5. The experimental conditions are introduced in [4]. Figure 5 includes 11 frames of images.

Figure 5 displays an obvious triple-bottom trend.

### 3.2. Downlink

In Figure 7, it is a group of data for stellar observation. The signal is limited in an uptrend and a horizontal fluctuation.

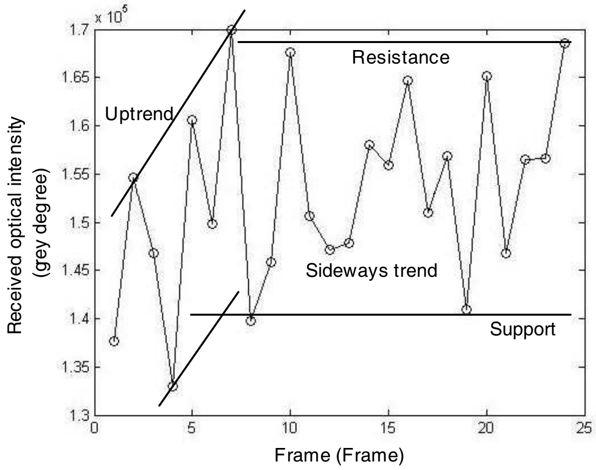

Figure 7: A group of data of a downlink.

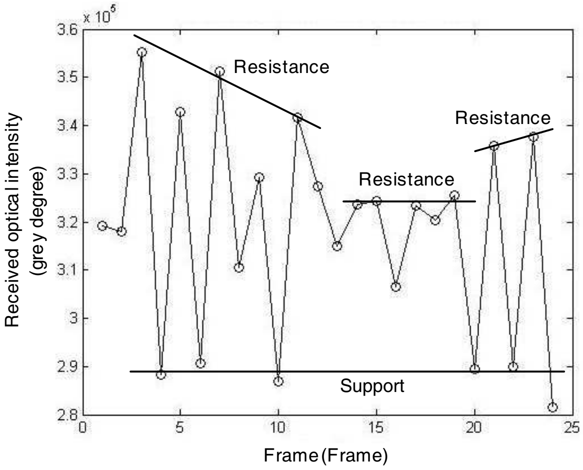

Figure 8: The other group of data of the downlink.

In Figure 8, it is the other group of data in the downlink. The signals move in horizontal fluctuations.

## 4. CONCLUSIONS

In this paper, the author establishes a theory model to describe how does optical scintillation fluctuate. The signals move according to the order of the trend, and there are some small fluctuations twist the trend. The author also discloses the second batch of experimental data to confirm the trend theory.

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