THE SCINTILLATION OF THE STARS

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1. INTRODUCTION

THE stars in the sky appear to us as mere specks of light having no visible extension. But they exhibit a remarkable feature, *viz.*, a noticeable fluctuation in their observed luminosity. The brightest stars also exhibit flashes of colour when they are located not too high up in the sky. This "twinkling" of the stars is a familiar phenomenon. Its real nature becomes clearer when by the aid of some simple optical device, *e.g.*, a mirror or a lens moved in appropriate fashion, the observer views the image of the star drawn out into a continuous circle of light. This method of observation reveals large and rapid fluctuations of brightness along the track of the moving image of the star. Striking changes in colour are also noticeable in the case of the brighter stars as thus examined. Observation of such stars through a prism which draws out their images into a spectrum of colours further reveals some highly interesting effects.

We are clearly concerned here with an atmospheric phenomenon. In other words, the scintillation arises as a consequence of the passage of the light from a star through the air before it reaches our eyes. But it is by no means easy to understand how such a tenuous medium as the atmosphere could give rise to the observed fluctuations of intensity. It is thus evident that scientific problems of great interest are presented to us by the observed effects. Astronomers are naturally interested in the scintillation of stars by reason of its relationship to the unsatisfactory atmospheric conditions which often interfere with their professional activities. An important aspect of the subject is the location in the atmosphere of the regions in which the disturbed conditions exist giving rise to the observed scintillation. This brings the subject into close relationship with the science of meteorology. Finally, we are concerned with the problem in optical theory of determining how the propagation of the light of a star is modified by its passage through the disturbed layers and gives rise to what is actually observed.

The present communication is not a review article and it is not proposed to survey the published literature or to discuss in detail any particular aspect of the subject. The purpose of the author is to set out a general view of the field as it presents itself to him and in doing so to indicate the basis on which he feels it is possible to reach a clearer understanding of the observed phenomena.

2. THE THERMODYNAMICS OF THE ATMOSPHERE

The light from a star has to traverse the entire atmosphere before it reaches the eye of the observer. The path traversed is the full height of the atmosphere if the star be at the zenith and increases progressively to several times that value as the star goes down in the sky and approaches the horizon. It follows that no attempt to explain the scintillation of stars can claim acceptance which does not take into consideration the actual condition of the atmosphere of the earth at all levels and their influence on the propagation of the light before it reaches the observer.

In the year 1899, the French meteorologist Teisserenc De Bort announced the discovery made by him of the existence of what he called the "Isothermal Layer of the Atmosphere" in its higher levels. The great importance of this finding was appreciated by meteorologists and it is now recognised that the lower part of the atmosphere known as the troposphere and the upper part known as the stratosphere exhibit different structures