observer and that a statistical treatment first suggested by Chandrasekhar may be used.²

It was found that, as the starlight passes downward through successive layers of turbulent air, the effect is much the same as if it were passing through successive transmission gratings, each grating being irregular in spacing in both of the horizontal directions. A certain amount of the incident starlight penetrates each layer without deflection, this undeflected ray corresponding to the zero-order image from a grating. The remainder of the light is diffracted at small angles to form the first- and higher-order spectra. The amount of light diffracted out of the path of the incident ray is directly determined by the effective thickness of the layers which must be penetrated. The effective thickness is here defined so that it takes into account the mean amplitude of the fluctuations in refractive index.

The angular width of the diverging bundle of rays received by the observer is governed by two effects: (1) the number and effective thickness of the layers through which the light has passed, since each layer fans out the bundle of rays emergent from the previous layer, and (2) the spacing of the atmospheric irregularities. A narrow spacing acts in the manner of a fine grating and gives relatively wide dispersion.

If the number and effective thickness of the layers can be determined from the amount of light removed from the path of the incident ray, then the angular width of the bundle reaching the observer may be used to determine the mean spacing of the atmospheric irregularities. In fact, the analysis shows that if the details of the angular distribution of the light in the incoming bundle of rays can be found with sufficient precision, one should be able to derive the detailed autocorrelation function for the density fluctuations in the average turbulent layer.

The mathematical details have been included in an Air Force technical report which is available on request.

1. *M. N.* **III**, 289, 1951.

2. *M. N.*, in press.

*Perkins Observatory,
Delaware, Ohio.*

MacRae, Donald A. Electric spectrophotometry.

The photoelectric equipment at the Warner and Swasey Observatory, and the Schmidt telescope with its objective prisms, have been used in a program of direct spectrophotometry. The spectrum of a star is trailed in the direction of its dispersion, over a narrow slit in front of the

photomultiplier, and the corresponding variations in the intensity of the light admitted by the slit are recorded on a Brown potentiometer.

Measurements of the recordings yield the energy distribution in the spectrum relative to some standard star (Vega). Since the slit admits about 40 Å these measures are much more nearly monochromatic than observations through color filters. Furthermore they possess the advantages of avoiding the influence of the strong absorption lines and of covering the spectrum continuously from 4000 Å to 6000 Å. A complete observation of one star requires only five minutes, and stars as faint as the eighth magnitude can be observed with the prism of largest dispersion.

Spectra in the range from O9 to A5 can be well represented by spectrophotometric gradients. For a star of later type there are clear indications, especially in the violet, of the deviations from the linear relation which is expected on the basis of black-body radiation.

The gradients show a well-defined variation with spectral type along the main sequence, and are sufficiently accurate ($\pm .02$ for a single observation) to show differences due to luminosity and of course to interstellar reddening.

When the gradients are compared with accurate color indices one finds a markedly non-linear relation which is attributed to the influence of the strong Balmer lines on the colors among the A stars. This shows clearly that only in special circumstances will there be straight-line relations among color systems, but observations such as these may provide a useful set of standards for intercomparison of such systems.

Color temperatures derived from these observations confirm the general nature of the well-known excess over effective temperatures.

The photoelectric spectrograms can also be used to measure the equivalent widths of the stronger lines. The hydrogen lines reach maximum intensity later than A0, and their variation with absolute magnitude is clearly shown.

*Warner and Swasey Observatory,
East Cleveland, Ohio.*

Milford, S. N. Possible tests on the red shift.

In this paper we look for tests on the velocity interpretation of the large red shifts in the spectra of distant galaxies. Three theoretical tests are derived. The assumption is made that if the red shift is an actual Doppler velocity effect, then local physical laws must be valid in the region of large red shifts. In particular we use special relativity theory.