the "effective level" falls, the temperature of the layer that gives rise to the line increases, owing to the temperature gradient in the stellar reversing layer. The observed fall in the intensity of the line is caused both by the reduction in the number of suitable atoms, and by the decreased contrast between the line and the background. The former cause predominates for strong (saturated) lines, and the latter for weak (unsaturated) lines.

As the atoms suitable to the absorption of the line considered decrease in number, the effective level from which the line takes its origin falls, and ultimately coincides with the photosphere (the level at which the *general* absorption becomes great enough to mask the *selective* absorption due to individual atoms). The line then disappears owing to lack of contrast. Immediately before the line merges into the photosphere (the approximate point estimated as "marginal appearance"), *all* the suitable atoms above the photosphere are clearly contributing to the absorption; in other words the *line* is unsaturated. The position in the spectral sequence of the marginal appearance of a line must then depend directly upon the *number of suitable atoms above the photosphere*; considerations of effective level are eliminated. Hence a constant P_e is used on page 184.

The conditions at maximum and marginal appearance of a line in the spectral sequence are to some extent reproduced for an individual absorption line at the center of the line and at the edge of its wing. A hydrogen line displays wings that may extend to thirty Angstrom units on either side of the center. The energy contributing to the wings is evidently light coming from hydrogen atoms with a frequency that deviates somewhat from the normal. Atoms with small deviations are more numerous than atoms with large deviations, and therefore the light received from them originates in a higher effective level. The line center corresponds to the highest level of all. At points far out upon the wings, lower and lower levels are represented, until, where the line merges into the continuous background, the level from which it originates coincides with the photosphere, and the "marginal appearance" of the line (if it may so be called) is reached. Accurate photometry of the centers and wings of strong absorption lines would seem to have an important bearing on the structure of the stellar atmosphere, as it would provide an immediate measure of the factor that produces the deviations from normal frequency. The success of parallel work in the laboratory [3] indicates that intensity distribution should be amenable to observation and to theory.

Observed Marginal Appearances

The spectral class at which a line is first or last seen is obviously, to some extent, a function of the spectrosopic dispersion used, for, with extremely small dispersion, many of the fainter lines fail to appear at all. A line will also probably appear somewhat later, and disappear somewhat earlier, with small than with large dispersion. It is therefore a matter of some difficulty to obtain measures of marginal appearance that shall be absolute, but the present discussion neither assumes nor requires them. The method used is designed for the estimation of *relative* abundances, and all that is required of the data is that they shall be mutually consistent.

In order to attain the maximum degree of consistency, the estimates used in this chapter were derived chiefly from the two series of plates mentioned in Chapter VIII. All the plates used were made with the same dispersion (two 15° objective prisms) and were of comparable density, and of good definition. The data furnished by the writer's own measures were supplemented by some estimates derived by Menzel [4] from a similar series of plates, of the same dispersion and comparable quality. The estimate of the marginal appearance of potassium was very kindly suggested by Russell from solar observations.

The observed marginal appearances of all the lines that are available are summarized in the table that follows. Successive columns contain the atomic number and atom, the series relations, the wave-length of the line used, and the Draper classes at

[3] Harrison, unpub. [4] H. C. 258, 1924.