late-type supergiants occurring in galactic clusters appear in those containing early B-type stars;² this statement is confirmed for the supergiants discussed here. The data available at present rather strongly suggest that the later-type supergiant stars do not in general coexist with early O-type stars, a principle which appears to be a higher-luminosity analogue of Trumpler's well-known conclusion that B stars and ordinary late-type giant stars do not coexist in galactic clusters. These results indicate that the course of stellar evolution of unmixed stars of masses up to four suns proposed by Sandage and Schwarzschild³ also holds for more massive stars.

Spectrograms taken at the Chile station of the Lick Observatory have been utilized to classify a number of southern supergiants. Supergiant stars of both early and late type appear in the B-star group near η Carinae: approximate corrections for interstellar absorption lead to a distance of this group about 2100 parsecs as determined from the estimated spectroscopic absolute magnitudes of four B-type supergiants. Several of the associated high luminosity stars of types F and G appear to have visual absolute magnitudes of the order of -8 .

1. *Ap. J.* **118**, 318, 1953.

2. *Statistical Astronomy*, p. 362, 1953.

3. *Ap. J.* **116**, 463, 1952.

Lick Observatory,
Mt. Hamilton, Calif.

Billings, D. E., C. Pecker and W. O. Roberts.
Study of profiles of coronal emission lines.

Coronal lines occasionally show a marked broadening in those very active regions of the sun's atmosphere that are characterized by flares and yellow line emission.¹ We have selected a number of spectrograms in which such broadening is apparent, and have subjected them to analysis, both by microphotometer and visually with a travelling microscope. Most of the work was on the red coronal line although in some cases the green and yellow line profiles were also analyzed. In one of the spectra, the distorted red line was clearly split into two parts separated by 3 Å, indicating that one fragment of coronal material was moving away from the observer at approximately 150 km/sec. Such evidence of large-scale motion was very exceptional, however. Most of the broadened lines were surprisingly symmetrical. Half-widths, corrected for instrumental profile on the assumption of Gaussian profiles, corresponded to temperatures ranging as high as sixteen million degrees, with the

greater number studied corresponding to six or seven million degrees. Profiles of the red line in less disturbed regions consistently corresponded to a temperature about 2.3×10^6 degrees. The broadened profiles generally differed appreciably from Gaussian form in the direction of triangular profiles.

We consider two interpretations for the line broadening, high temperatures and randomly distributed macroscopic velocities. According to the latter, and assuming a temperature of 2.3×10^6 degrees, we compute root mean square macroscopic velocities as high as 63 km/sec. The symmetry of the line profiles, however, suggests the high temperature hypothesis. One set of profiles of special interest is that of the yellow, red, and green coronal lines observed on February 2, 1950. When the abscissas of these profiles are corrected to the same wave length and atomic weight, using 40 for the atomic weight of the yellow-line emitting ion, the profiles coincide well within the limits of experimental error. This coincidence holds even though the shape of the profiles departs considerably from Gaussian. If, as Menzel has suggested to us, we interpret the shape of the profiles as a superposition of various temperatures along the line of sight, we need assume only that Edlen's original identification of the yellow line as Ca XV is correct, and that the sources of coronal emission are distributed in the same proportion in the various temperature regions along the line of sight. If we adhere to the macroscopic velocity concept, we must postulate a very special distribution of velocities for the yellow-line emitting atoms, an improbable situation.

We are confronted with the dilemma of the coexistence of atoms radiating $H\alpha$, and the coronal lines $\lambda\lambda 5303, 6374$ and 5694 implying a wide range of ionization temperatures. A theoretical explanation of how this can occur has, however, been given by Goldberg and Menzel.² We find in active centers, moreover, a definite correlation between line broadening in $H\alpha$ and in the red coronal line, suggesting independently the coexistence of these atomic species at comparable kinetic temperatures.

This work was supported by the Office of Naval Research.

1. Dolder, F. D., W. O. Roberts, and D. E. Billings, *Ap. J.* **119**, 120, 1954.

2. Centennial Symposia, pp. 279-297, *Harv. Obs. Monogr.* No. 7, 1948.

High Altitude Observatory,
Boulder, Colo.