In the beginning of this review, I paraphrase three statements from Paul W. Merrill (1960). (1) In the spectra of long-period variables, absorption lines of neutral metals show a shortward displacement increasing algebraically with excitation potential, probably due to atoms moving outward in the star's upper atmosphere with an expansion velocity of the order of 20 km s\(^{-1}\). (2) About 6 weeks after maximum light emission components appear within the broad absorption at H and K of Ca II, but displaced about -100 km s\(^{-1}\). A similar, but less extreme, behaviour is known for classical cepheids. (3) In quasi-constant red giants, the resonance lines of Ca II, Ca I, and Sr II show circumstellar components displaced shortward relative to the normal stellar photospheric lines by a velocity which is correlated with the spectral type, typically -8 km s\(^{-1}\) for M6 II to -25 km s\(^{-1}\) for class M0 III.

From the very few specific citations in the literature, Table 1 lists examples of much larger shifts detected on high-dispersion spectrograms of extremely luminous stars. The stars named are somewhat fainter than any yet studied in detail in the far ultraviolet. Morton (1976) quotes a velocity of -2260 km s\(^{-1}\) for O VI \(\lambda1031\) in the upper chromosphere of \(\zeta\) Pup.

It is noticeable that, in addition to the progression by excitation potential, already discussed by Merrill and the cited authors of the recent papers on supergiants, there appears a progression with photospheric temperature among stars of the highest bolometric luminosities. Imhoff (1976) demonstrated among G, K, and M stars respectively, such a progression with luminosity class exists. For the profiles of Ha with "reverse P Cygni" emission, the trend to larger velocity displacements from the chromospheres of more luminous M stars is seen in Figure 1. Some of the displacements change with time; Smolinski et al. (1979) have noted an outburst from recent spectra of HD 217476 in which ions with lower excitation potential have velocities similar to Ha.
Fig. 1  Hα line profiles of early M stars of increasing luminosity. Uncorrected for instrumental profile. Vertical line marks rest wavelength of Hα. Wavelength increases to right.

(From Imhoff 1976)
For supergiants of classes A and B, a progression with excitation potential has been discussed by several authors. Figure 2 summarizes the measures by Hutchings (1968) on the brightest member of the cluster NGC 6231. Conti (1977) has presented similar evidence for the Of star HD 148937 (see Figure 3).

It seems reasonable to suggest that the outward acceleration of matter escaping from stellar chromospheres is related to the age and possibly the mass of the star concerned. Each of the stars named in Table 1 has a bolometric luminosity of about two million suns.

I am indebted to R.E. Taam for the suggestion that this type of chromospheric activity may even be detectable as X-ray emission from very luminous stars.
Fig. 2 Progression of velocity displacements for absorption lines in the spectrum of HD 152236 (ζ Sco).

(From Hutchings 1968.)
Fig. 3 Velocity progression of the Balmer, He I and He II absorption lines in the spectra of HD 148937.

(From Conti 1977.)
REFERENCES