GENERAL DISCUSSION

Plavec: Could someone say something about the status of some of these stars with very large mass loss rates? P Cygni, for example.

Hummer: Is there any expert on some of these pathological cases?

Bidelman: I don't have anything to say in defense of P Cygni, but I think that one should always be suspicious of a star that just suddenly appears! I have often suspected that P Cygni might be star nearing the end of its initial gravitational contraction stage, though I have no idea of how this can be proved or disproved. It is certainly very different from normal supergiants. It also appears rather red for a star of its class.

Snow: From Copernicus data we have derived the H I column density towards P Cygni, and from the literature we have found the measured diffuse interstellar band strenghts. Both of these quantities correlate well with interstellar reddening, and both indicate that E(B-V) for P Cygni is between $0^m.3$ and $0^m.4$, much less than the value E(B-V) = 0.6-0.7 which is derived from the UBV photometry and the assumption that the star's intrinsic colors are those of a normal early B supergiant. The lower value of E(B-V) leads to a reduced distance estimate and hence a lower luminosity for the star than has commonly been assumed. The UBV photometry may be influenced by the star's infrared excess, which may contribute to the V band more than to B, introducing a spuriously high value of E(B-V).

Van Blerkom: P Cygni differs from the O stars in that: (1) there is no evidence for outflow velocities in excess of 300 km s^{-1}; the emission wings on Hα and He I can be attributed to thermal electron scattering; (2) the excitation of the wind is quite low -- no He II is detected, for example; (3) H line profiles have been interpreted by three different models -- decelerating flow, a monotonically increasing velocity with radius in which a slow acceleration occurs, and an accelerating-decelerating-accelerating envelope. Thus, there is an obvious non-uniqueness in the models which does not seem to be as severe for the O stars.

Underhill: Some years ago Mart de Groot studied the spectrograms of P Cygni obtained over the years at Mt. Wilson. He showed that most H lines often appear to have three absorption components. Two remain stationary; the third appears to oscillate in about 114 days. This suggests standing waves of density at some places in the very extensive atmosphere. P Cygni is not at all typical of normal B-type supergiants.

van den Heuvel: As to P Cygni one can make some speculative theories on the origin of the mass outflow (van den Heuvel 1976). If one looks at a mass-exchange close binary with a large initial mass ratio, one expects such a system to go through a common envelope stage during which much of the transferred matter is expelled from the system,

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as the low-mass component cannot accept it (Flannery and Ulrich 1976). Now, one can go one step further, and presume that the companion star is a compact object, i.e., that P Cygni is a later stage of evolution of a massive X-ray binary. In such systems one expects the compact star to be swallowed by the envelope of its supergiant companion. The accretion luminosity will come out in the optical region, as the envelope is optically thick to X-rays. A spiral-in binary of this type can be quite long lived (Bodenheimer, Taam and Ostriker 1978), and, as we see quite a number of X-ray binaries in the sky, one also expects to see a couple of these spiral-in binaries in the sky. A possible support for this idea in the case of P Cygni may be the photometric period of 0.5 days, claimed by Magalasvili and Kharadze, some years ago. This seemed quite a reasonable period for a spiral-in binary descending from an X-ray binary within a period of a few days. It seems like an exciting idea that P Cygni would be a descendant of a massive X-ray binary like Cygnus X-1 or Cen X-3.

Ludd: I want to make two remarks about P Cygni: (1) Using extended series of spectrograms it was found that the absorption components of H9 and H10 have 47^d period; that is two times shorter than obtained by de Groot; (2) using all observational data kindly presented by Prof. Kharadze and period-searching computer routine the $0^d.5$ photometric period by Kharadze and Magalasvili was not confirmed.

Thomas: I note the repetition of the "belief" that luminosity -- or luminosity/escape energy -- is what describes mass loss. I think you are being too serious and religious. You are assuming that (T_{eff}, g) suffices to model an atmosphere -- but none of these "theories" have proved this. It is in no way clear that just because two stars lie in the same (T_{eff},g) box that they will have the same mass loss: Or that even [luminosity, spectrum] suffice to define mass loss, emission lines, etc. These problems are to be investigated -- not assumed as so many of you are doing. Some of you say P Cyg is an unusual, highly individual star. Agreed -- and so what? We must show that all stars are not highly individual before we assume that they are not.

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