GENERAL DISCUSSION

Underhill: The deduction of relative abundances of N, C, He and H from the strengths of the emission lines in Wolf-Rayet spectra is very tricky. We do not yet have a secure theory of how the spectral lines are formed and what controls the ionization balance under the different sets of state parameters (electron temperature, density, flow velocity, geometric size) that exist for Wolf-Rayet stars. Therefore, I urge caution in concluding that one or other element is over- or underabundant. In particular, some results which appeared recently in the literature (Willis and Wilson, 1978 M.N.) suggest that WN stars have a normal N/He ratio but that WN stars are deficient in C and H in contrast with Conti's statement that WN stars have an overabundance of N. The WC stars have an overabundance of C according to Willis and Wilson.

Vanbeveren: Did you use a spherical symmetric approximation for the radiation force? In that case I think that the shape of those critical surfaces (also computed by Kondo and McCluskey) is wrong as I said already earlier in this symposium. The picture changes totally if you include gravitation darkening.

Leung: Does your model take into account that the back side of the component cannot see the other star? A star is transparant to gravitation, but it is not transparant to radiation.

Van Blerkom: If a theoretician predicts all elephants have ten legs, but observers agree that they have four, can the theoretician insist that his model must be correct? This remark is a metaphor. For the nitrogen enhancements that the theoreticians insist must be present in the X-ray binaries, but the observers say is not at all apparent. Is there a problem here that should be discussed?
Conclusion at end of long discussion : All elephants have ten legs, but hide behind trees and only show four legs at any one time.

Dearborn: 1) The question that must be answered before it can be claimed that theory disagrees with observation, is how much ^{14}N enhancement is required to be observed. Walborn has indicated to me that the visible components of many X-ray binaries are not good candidates for observing ^{14}N enhancement (due to spectral type, rapid rotation, or poor data). The best candidate Cyg X-1 shows no ^{14}N enhancement, but the supposed mass loss is only marginally able to produce ^{14}N enhancement, a slightly lower initial mass, or higher observed mass is consistent with no enhancement. Composition

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can however give a significant clue to the amount of mass lost.

2) Dr. Chiosi is correct that the molecular weight gradient will drive thermohaline mixing and homogenize the envelope on a thermal time scale. The time required to convert ^{12}C to ^{14}N in the envelope of the now more massive mass accreting star is also short compared to the nuclear lifetime, so the point where ^{12}C = ^{14}N moves outward in the mass accreting star. Therefore, when it begins to lose mass it does not have to lose all of the accreted mass plus its own original ^{12}C rich envelope. Mass transfer does not therefore allow a star to lose mass and not show ^{14}N.

van den Heuvel: For the X-ray binaries there is indeed the problem that people claim that they are very undermassive (have lost half of their mass by wind), which implies the prediction that they should show a nitrogen abundance anomaly which is not observed. I think that this may be a serious question.

Abbott: In regard to the relation of emission line strength of lines in the visible to mass loss rates, I would point out that the emission lines are measuring the gas density of the wind. The gas density depends not only on $\dot{M}$, but also on the velocity law, temperature, etc. Using the law $v(r) = v_\infty(1-\frac{r_*}{r})^{1/2}$, the column density of material in the wind, $\int_0^\infty N_e dr$, scales as $\frac{\dot{M}}{v_\infty}$. For example even if ζ Pup and 9 Sgr had exactly the same $\dot{M}$, the column density of material in the envelope of ζ Pup would be ~ 30% larger. Since the emission line strength of a line like H_α scales as $\int_0^\infty N_e^2 dr$, this dependence is exaggerated even more. Mass loss rates derived by Hutchings based on emission in the visible will be affected by this dependence on gravity. This will cause him to underestimate the rate of mass loss for the higher gravity main sequence stars.

Tutukov: We could explain overluminosity without too extensive mass loss at least of close binary components if we assume that duplicity promotes over mixing what increases the mass of the core enriched by helium. Observable mass loss rates give us no possibility to understand the absence of bright red supergiants.
That absence of very bright red supergiants ($L \gtrsim 10^5 L_\odot$) is possible says us that for those supergiants the mass loss process is so extensive that stars are quite obscured by

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circumstellar gas-dust envelopes. Probable candidates of such stars could be OH/IR stars. When the hydrogen rich envelope will be lost, the star quickly starts to move to the WR region of the HR diagram. So, that scenario seems now a probable one for the formation of single WR stars and should be developed.

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