FOURTH DISCUSSION SESSION

(Friday morning; 8 September, 1972)

(following the review paper by K. O. Wright)

Chairman: O. C. Wilson

O. C. Wilson: We thank Dr. Wright for his well-presented review, and invite questions and discussion of his paper.

Bolton: I have some comments and a question. First, in regard to these reverse P Cyg profiles in the spectrum of θ Ori C, I think the situation there is not quite so simple as Conti seemed to believe in his publication. Walborn at David Dunlap Observatory has some lower-dispersion spectra that show a 'regular' P Cyg profile. Therefore, we cannot be dealing with simple infall of matter and the relationship to YY Ori stars is tenuous at best. Second, it has been my impression from reading the literature recently, particularly the works by Mihalas and collaborators, that the Bowen fluorescence mechanism does not give an adequate explanation of the Of-star emission but that these phenomena find a natural explanation in the non-LTE reference frame. In connection with this, Mihalas* has shown that some of the emission features are luminosity sensitive. Both Walborn (1971) and Conti and Alschuler (1971) have recently given luminosity classifications for the O-type stars, and they both define a class of supergiants. In view of Dr. Wright's comments on the O-type supergiants in his review, I would like to hear his and Dr. Underhill's opinion of this classification.

Underhill: Regarding reverse P Cyg profiles, they have emission to the violet of the absorption. They are not very common, but neither are they very rare. For instance, I've obtained spectrograms showing Hα for a good many B-type supergiants from time to time. One time the emission is a bit stronger on the red side, another time on the violet side of whatever absorption there is. Generally, the lines are pretty well filled in and you really don’t see anything – just a little bump if you make intensity tracings. The simple, uniform model is either an expanding or a contracting atmosphere, but, in fact, the atmosphere changes and the whole Hα line is neither absorption nor emission, but just slight undulation up or down on one side of the nominal profile. We have a more complex situation than a simple uniform expanding sphere, although what Conti says is right as a very first order of approximation.

About the supergiant early O-type stars, how do you define a supergiant? It’s quite easy for late-type stars for which there is a large difference of magnitude between stars that are very bright and have a characteristic type of spectrum, called supergiants, and those that are on the main sequence. There are the stars called giants too: they are all separate. But once you consider the O-type stars, those on the main sequence

* See Hummer's discussion on p. 277.
have $M_v$ about $-4$, maybe as bright as $-5$, while supergiants, no matter what type they are, are usually of $M_v$ only about $-6$ or $-7$. The uncertainty in determining the absolute magnitude is so great that it is very hard to say, at type O5, that you have isolated different absolute magnitude groups. I think the terms 'supergiant' and 'main-sequence' are hardly relevant considering the uncertainties in the distances of these early O-type stars. Some of these stars show evidence that their atmospheres are expanding a little more than those of others, but I would hesitate to use the term 'supergiant' because it has so many other connotations for the later-type stars. In any case, the atmospheres are so expanded that you have to consider non-L.T.E. physics — real physics. You cannot argue from the equations of thermodynamic equilibrium.

O. C. Wilson: I gather that, in a sense, what you're saying is that the spectroscopic criteria are just not sharp enough?

Bolton: I don't want to let that comment go by without challenge. The spectroscopic criteria are certainly quite sharp. I have seen the spectra, and even I would have no trouble classifying the stars. I think that there can be no doubt that the spectroscopic classes of Walborn and Conti are real. Furthermore, interpretation of a luminosity effect does not require that one invoke LTE, or non-LTE, or magic. One must simply get distances or sometimes only relative distances. I don't want to minimize the difficulties involved in this, particularly the difficulties in deriving absolute magnitudes, but one frequently finds O-type stars of two or more classes in the same cluster. Then the photometry gives the luminosity differences directly and easily. It is true that spectroscopic binaries can complicate the interpretation, but they cannot account for more than $0.75$, and a range of at least three magnitudes is observed.

Underhill: You can do this. I don't quibble with that, but to attach a physical meaning to the class is the difficult step.

Thackeray: As to the absolute magnitudes of the O-type stars, may I suggest that a little more work on the Magellanic Clouds will give us a pretty safe answer whether the luminosity of an O5 star can reach anything like that of a later-type supergiant. Our work in Pretoria, scratching the surface, didn't show up any O-type star brighter than $m_v=12$ or $12.5$, whereas A-type stars are known with $m_v=9.5$ or $9.2$. We are doing more work in Pretoria, but I think it's very unlikely that we shall turn up an O5 star brighter than about $12^{m}2$.

Popper: I'd like to ask a question about the so-called reverse P Cyg profiles, such as are found in the spectrum of $\theta$ Ori C. What are the actual velocities? Is the emission-line or the absorption-line velocity that of the star? To interpret the profiles, you must have some picture of what the velocities are, and, if there is a change, what it is that is changing.

Wright: Conti (1972) found that the absorption was redward displaced, with some variation, and the emission was violet-displaced.

Popper: It seems to me that we are not seeing infall of matter, and then outfall, but that we are seeing an expanded shell with a changing distribution of matter in it. Sometimes the part behind the star is stronger.