CONCLUDING REMARKS : LOOKING AHEAD

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The absence of concensus on several of the problems which have been discussed during the meeting is perhaps the best demonstration of the usefulness of the Symposium .

The history of science is there to testify that consensus does not mean that the truth is known . However, the absence of consensus is the proof that further work has to be carried in order to find out who is right and who is wrong . And perhaps everyone is wrong !

The conflict between models or rules and new observations has always been the source of new progresses . It is worth, in this respect, to quote the story told by H.N.Russell in 1938 :

"... I was visiting my friend and generous benefactor, Professor Edward C.Pickering . With characteristic kindness, he had volunteered to have the spectra observed for all the stars - including comparison stars - which had been observed in the observations for stellar parallax which Hinks and I made at Cambridge, and I discussed . This piece of apparently routine work proved very fruitful - it led to the discovery that all the stars of very faint absolute magnitude were of spectral class M . In conversation on this subject (as I recall it), I asked Pickering about certain other faint stars, not on my list, mentionning in particular o^2 Eridani B. Characteristically, he sent a note to the Observatory office, and before long the answer came (I think from Mrs.Fleming) that the spectrum of this star was A . I knew enough about it, even in those paleozoic days, to realize at once that there was an extreme inconsistency between what we would then have called "possible" values of the surface brightness and density . I must have shown that I was not only puzzled, but crestfallen, at this exception to what looked like a very pretty role of stellar characteristics ; but Pickering smiled upon me,and said : "It is just these exceptions that lead to an advance in our knowledge," and so the white dwarfs entered the realm of study ."

I would like then to mention what , I think, are some of the weak points of our meeting .

A. Maeder and A. Renzini (eds.), Observational Tests of the Stellar Evolution Theory, 583–585.

Mass loss is an important factor of stellar evolution. From the production of white dwarfs to the production of WR stars, mass loss has to be introduced in due place, and with the proper intensity . However, it si quite obvious that we do not understand completely the mechanism of mass loss, and that we do not have a consistent theory of mass loss. HEAO2, with the Einstein observatory, has shown in stars the presence of unexpected chromospheres, and it has been shown by Leroy and Lafon (1982) , in the case of hot stars, that if radiation pressure can achieve the final velocity of the wind, a chromosphere is necessary, in order to provide the actual flux of matter . We believe that the formation of a chromosphere is the key of stellar winds. However, we do not have a full, consistent theory of the formation of chromospheres. Acoustic waves are important, electromagnetic phenomena must probably be included, but their presence and their effects are Ω - dependant . Are the stellar winds related to the rotation and how ?And which fracion of the stellar winds is generated by pulsations ?

Mass loss is not a steady process . The rate of mass loss is time dependant . There are activity periods, where $\dot{M}$ is large, follown by quiscient periods . Is there an explanation of this sort of relaxation process ? The effect of mass loss on stellar evolution is taken into account by introducung sort of time average of mass loss . Is that correct ? During steady mass loss, entropy adjustment of a star takes place easily , but as mentionned by Shu and Lubow (1981) in the case of binaries, is it still the case if mass loss takes place through a succession of bursts ?

Finally, what is the Z dependance of mass loss ? The depth of the convective zone, the chromospheric structure, the effect of radiation pressure are all Z-dependant. We can expect some influence of the chemical composition on mass loss .

Altogether, the only reliable quantitative estimate of mass loss is given on one side by the estimate of the mass of the progenitors of white dwarfs (8 to 10 solar masses) , and by the estimate of mass loss from the WR progenitors ($M \gtrsim 40$ solar masses) compared to the actual mass of WR stars.

I have just mentionned the connection between chromosphere, rotation and mass loss . This brings me to a series of unsolved questions related to rotation . What about the dynamo mechanism ? What is in this connection the origin and the fate of Ap stars ? What are their descedents ? We have learned about the conditions of appearance of instabilities . But what about the conditions of disappearance of the instabilities ? Is there a sequence of critical Ω's corresponding to various levels of instability and mixing, up to the Ω of the blue stragglers ? Is it possible to measure the rotation of evolved stars ? and what about Veq of the blue stragglers ?

Nuclear processing, mixing, dredge-up, winds have been extensively mentionned, but there is a feed back mechanism which remains to be understood . The depth of the convective zone is Z-dependant; the wind production is Z dependant; the way in which chemical elements are expelled duction is Z dependant; the way in which chemical elements are expelled into the galaxy is also Z-dependant . We then have also the rate of mixing in the galaxy, so that the whole loop :

interstellar matter ←
star formation
stellar evolution
elements ejection
galactic mixing →

is Z dependant . Is the loop stable or unstable, and at what time scale?

There still question concerning the absorption coefficient which seem to be yet unsolved, despite the important improvements obtained during the last years .

High precision astrophysics , with the arrival of high precision parallaxes within a few years (HIPPARCOS) will provide us with new data of a yet unknown precision : 2% in the luminosities, 3% for the masses , for a total number of perhaps100 binaries . In the mean time, high resolution spectroscopy will allow the detection of subtle and important variations in the surface abundances . Without writing the full list of new and high precision measurements which will come, we can remember the estimate of Harwit (1981) of about one hudred discoveries to come with the use of better and well adapted resolution in time, frequency, light, angular size and unlimited range of wave length .

Coming back, as a conclusion to H.N.Russell quotation , we shall conclude by recalling that the conflict between observation on one side , and rules , models or theories on the other side is always the source of new discoveries .

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