B. SHORT PERIOD VARIABLES, HORIZONTAL AND ASYMPTOTIC BRANCH EVOLUTION AND PLANETARY NUCLEI

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VARIABLE STARS AND EVOLUTION IN GLOBULAR CLUSTERS

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DISCUSSION

Cox: May I ask about these period changes? There has been this problem (that maybe you have overcome, maybe you have not) about the observed period changes which are too rapid. What you are predicting is rapid negative changes, but not very rapid positive changes.

Demarque: That is right.

Cox: Have you compared that with the observations?

Demarque: It is very difficult to get anything consistent out of the people who make the observations.

Cox: My impression was that they had rapid changes but they were both positive and negative.

Iben: And of about the same amplitude. In ω Cen, they tend to be in one direction predominantly but they are all about a factor of 10 larger than evolutionary changes during the major core He burning phase.

Cox: But he has got the factor of 10 now, Icko.

Iben: No. If you look at these things, 10^6 yr were spent in that little spike out of 10^8 yr. That means only one out of 100 stars in the instability strip should be doing that, but they are all doing it.

Demarque: I think it would have to be demonstrated that such jagged composition profiles do exist and we would like to be able to establish a time scale of any changes in this profile.

Iben: It seems to me that a number of discrepancies that you have caused to come about could disappear if perhaps semi-convection was not quite as important as your calculations seem to indicate. That is, the lifetime argument suggests only the order of 10% helium, for example, whereas pulsation plus observations say something like 20%, and without semi-convection it says 30%. I would argue that this suggests that the truth lies somewhere in between leaving out semi-convection altogether and treating it to the extent to which you do. The next point is that the BL Her stars are certainly there and I think are more abundant than W Vir (or Pop. II Cepheids) by quite a bit and that the tracks that you argue now replace the superhorizontal branch stars do not seem to get over there far enough.

Demarque: The particular one you saw did not but of course there is a whole spectrum all the way to the star that will go up the asymptotic branch. The interesting thing about it is that, only those that will not become asymptotic branch stars will stay there long enough to become BL Her stars because the others move up the asymptotic branch too fast.

Tayler: To return to your semi-convection zone, is it not true that in the region which you are interested in, the mixing length is probably comparable with the radius? The mixing length is normally very small compared to the radius, but here the mixing length would be getting rather large and therefore in order to really understand what is going on you probably need a very much better idea of what convection is doing than in a simple mixing length theory. Maybe you get considerable irregularities in your semi-convection due to this sort of thing.

Demarque: The words 'semi-convection' are misleading. We do not treat any type of convection. We just say there is some mixing.

Tayler: What I mean is that if you are in a situation where you have got the scale height being of the same order as the radius you would expect that you might get irregularities in whatever goes on in the semi-convection which might lead to something which would complicate your story, maybe in the way you want it complicated.

Zahn: About semi-convection again, you refer to the ocean but in the ocean you have a situation with warm water on the top. It is colder underneath and the "salt" content is in the opposite direction. So you have a stable temperature gradient and an unstable salt gradient whereas in a star it is just the contrary, you have an unstable temperature gradient and a stabilizing μ gradient. This situation has been studied in the lab where you have heat below and have an unstable temperature gradient but you have

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a stabilizing salt gradient. What you get in the lab is a finite amplitude overstability which mixes the whole tank. It is a finite amplitude overstability which means there is a threshold for that and nobody knows what that threshold would be in a star. There is one difference, in the lab the whole situation is dynamically stable, there is a stream constant, whereas you start with a neutral equilibrium and maybe that case is special. So one might expect a mixing of the whole semi-convective region leading to a homogeneous region.

Demarque: That could have essentially the same effect as the composition instability mentioned earlier. I should add that this possibly may have a relation to the β Cephei phenomenon because there is reason to believe that the same effect occurs but at much lower central hydrogen abundance, at the time of the hydrogen exhaustion. It could be very interesting to study this line.

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