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Contribution to JD4: General Discussion III

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Abstract. This is a written version of comments made during the final *Round Table Discussion* at JD4.

This was indeed an interesting meeting with lots of interesting results discussed. Rather than go over again what has been said, I'd like to draw attention to what I see as two key questions relevant to the debate concerning the relative importance of processes occurring early in the life of a globular cluster ("primordial processes") and processes occurring in the stars we observe today ("mixing processes"). These are:

(1) *In a given cluster, is the total abundance of C+N+O constant from star-to-star, even though the individual C, N and O abundances vary substantially?*

In my opinion we don't have a definite answer to this question. It is, however, a vital one since, at least as I understand it, constant C+N+O is a necessary outcome of any mixing process. On the other hand, a primoridal process, such as pollution from the winds of AGB stars, is not required to have C+N+O constant and indeed a variation in C+N+O is almost expected.

(2) *In a given cluster, is it really reasonable to imagine that all the 'second generation' stars can be formed from the ejecta of AGB stars?*

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At this meeting we have frequently heard the suggestion that the Nitrogen- and Sodium-rich, Carbon- and Oxygen-poor stars may have been formed from the mass lost by thermally-pulsing upper-AGB stars. I think we are now in a position where we could attempt to quantitatively evaluate this question for a cluster like 47 Tucanae. In the outer parts of this cluster, the numbers of CN-strong and CN-weak stars are roughly equal. In the inner regions, however, as shown originally by Norris & Freeman (1979) and confirmed by Paltoglou (1989), the number of CN-strong stars considerably exceeds the number of CN-weak objects. The data of Paltoglou (1989) suggest that inside the half-mass radius of the cluster (2.8′, Harris (1996)), the CN-strong stars outnumber the CN-weak stars by a factor of approximately 2.5, while outside this radius, the number ratio is more like 0.8. If we assume that the two populations have the same current mass function, then these numbers imply that the mass of the CN-strong stars exceeds the mass of the CN-weak stars by about 40 percent. Clearly a rather unusual mass function is then necessary for the *initial* generation in order to provide the required mass for the subsequent generation, a point first made some time ago by Smith & Norris (1984). Whether such mass functions are possible remains problematical. One must also keep in mind the very high degree of chemical homogeneity in most clusters for the elements other than C, N, O, Na, Al and occasionally Mg. In the context of unusual mass functions, it would seem that the requirement is not only that the initial cluster mass function be biased strongly towards stars that undergo the thermally-pulsing phase of AGB evolution, but also that the upper mass cutoff of such an IMF be below the maximum mass for the formation of an O-Ne-Mg white dwarf, in order to avoid the occurrance of heavy element polluting SN II; i.e. an upper mass cutoff of less than ~8 solar masses. In such a case the cluster iron-peak elements must then come from pre-cluster processes and there is no self-enrichment.

On the other hand, if one does not like unusual mass functions, then perhaps we should consider forming the 'second generation' from material whose chemical abundances have been modified by the material lost from massive stars, perhaps in the Wolf-Rayet phase, prior to the onset of the first supernovae. However, once again the question of whether this is plausible, and particularly whether sufficient mass with the 'right' composition can be generated this way, is not easily answered. It seems we'll be discussing this problem at future IAU General Assemblies for some time yet.

References

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