THE ABUNDANCE OF OXYGEN IN M92 GIANTS

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Studies of the carbon and nitrogen abundances in metal poor giants have generally supported the models of Sweigart and Mengel (1979) which indicate the action of meridional circulation in CN-processing metal poor red giant envelopes. Carbon *et al.* (1982) find the trends in the carbon and nitrogen abundances in M 92 stars to be at least qualitatively consistent with CN-cycle processing of the envelope, but stars at all phases of giant branch evolution have unusual, and unexplained, carbon and nitrogen abundances. The oxygen abundance is the missing piece of information which may explain what's going on. Sweigart and Mengel's models suggest that ON-processing might also occur in the most metal poor giants. The sample of giants in M 92 for which Carbon *et al.* have provided carbon and nitrogen abundances is ideal for the determination of oxygen abundances to look for the effects of ON-processing. Once the oxygen abundances are known, the sum C+N+O can be computed to see if it is constant along the giant branch or varies from star to star.

Spectra of the λ6300 line of [O I] were obtained for 6 stars at the top of the M92 giant branch with the KPNO 4M Telescope and echelle spectrograph, using a CCD detector with high resolution (0.22Å) and high signal-to-noise (>50). The resolution is sufficient to separate the Sc II feature 0.4Å longward of the [O I] line. Synthetic spectra were calculated assuming an oxygen abundance of Log ε(O)=6.67 ([O/H]=[Fe/H]=-2.2). A carbon abundance of [C/Fe]=-1.0, consistent with the results of Carbon *et al.* was assumed for all 6 stars. Model atmosphere parameters of Carbon *et al.* were adopted for the synthetic spectrum calculation. The oxygen, carbon, and nitrogen abundances are given in Table I, and log ε(O) is plotted vs. log ε(N) in Figure 1.

These results indicate that the sum of the carbon, nitrogen, and oxygen abundances in bright M92 giants remains constant within observational uncertainty, despite large variations in the abundance of nitrogen from star to star. The constancy of C+N+O suggests that the abundance differences are due to variation in the degree of mixing, and not to initial differences in the amount of C+N+O.

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Table I - The Abundance of Qxygen in M92 Giants

Star	T_{eff}	log g	Log W/λ	[C/Fe]	[N/Fe]	[O/Fe]	Log (C+N+O)
III-13	4210K	0.66	19mÅ	-1.0	+0.3	+0.2	6.98
VII-18	4230K	0.71	<6mÅ	-1.2	+1.0	<0.4	<6.93
III-65	4340K	0.94	15Å	-1.2	+0.5	+0.1	6.96
XII-8	4510K	1.17	<12mÅ	-1.0	-0.3	<0.2	<6.98
V-45	4530K	1.22	12mÅ	-1.0	+0.0	+0.2	6.99
II-70	4580K	1.36	<12mÅ	-1.0	-0.3	<0.2	<6.98

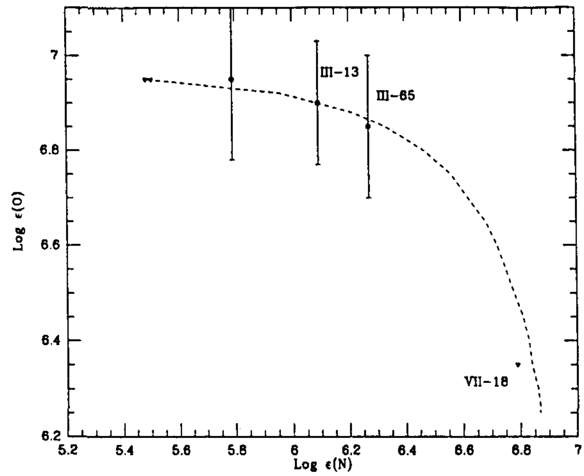

Figure 1 - Log ε(O) vs. Log ε(N) for M92 giants. Upper limits are shown as triangles. A curve of constant N+O is indicated.

The abundances of nitrogen and oxygen are anti-correlated (see especially the pair of stars III-13 and VII-18, which have very similar atmospheric parameters, but very different oxygen and nitrogen abundances). The anti-correlation of oxygen and nitrogen suggests that the ON-cycle has been active to modify the abundances, starting at about M_V = -1.5. A curve of constant C+N+O, with oxygen being converted to nitrogen, is drawn in Figure 1 for comparison to the data. The original oxygen abundance in M92 was probably Log ε(O)=6.98, or [O/Fe]= +0.2, and [C+N+O/Fe]= +0.03 ± 0.05.

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