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Mg Isotopic Ratios in Giant Stars of the Globular Cluster NGC 6752

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Abstract

We have measured Mg isotopic ratios in 20 bright red giants in the globular cluster NGC 6752 based on high-resolution (R$\sim$110,000), high signal-to-noise spectra obtained with UVES on the VLT. We find a variation in the ratio ^{24}Mg:^{25}Mg:^{26}Mg with values ranging from 53:9:39 to 83:10:7. We combined our sample with 21 RGB bump stars (Grundahl et al. 2002) and measured the abundances of O, Na, Mg, Al, and Fe. The abundances of the samples are consistent and exhibit the usual anticorrelations between O-Na and Mg-Al. We found a positive correlation between ^{26}Mg and Al, a mild anticorrelation between ^{24}Mg and Al, and no correlation between ^{25}Mg and Al. Neither the elemental nor isotopic abundances show a dependence on evolutionary status and, as Gratton et al. (2001) have shown, main sequence stars display the abundance variations. This strongly suggests that the star-to-star abundance variations are a result of varying degrees of pollution with intermediate mass AGB stars being likely polluters. The composition of the ambient and processed material can be inferred from the extremes of the abundance variations. The least contaminated stars (lowest Na and Al and highest O and Mg abundances) have a Mg isotopic ratio around 80:10:10 and a composition ([O/Fe], [Na/Fe], [Mg/Fe], [Al/Fe]) $\simeq$ (0.6 ,–0.1, 0.5, 0.0). The most polluted stars have a Mg isotopic ratio around 60:10:30 and a composition ([O/Fe], [Na/Fe], [Mg/Fe], [Al/Fe]) $\simeq$ (–0.1, 0.6, 0.3, 1.2). The least polluted stars have abundances of ^{25}Mg and ^{26}Mg relative to ^{24}Mg that are considerably higher than predicted for ejecta from $Z = 0$ supernovae. Zero metallicity AGB stars may be responsible for these higher abundances. Our measured Mg isotopic ratios reveal another layer to the globular cluster star-to-star abundance variations that demands extensions of our present theoretical knowledge of stellar nucleosynthesis by giant stars.

References

Grundahl, F., Briley, M., Nissen, P. E., & Feltzing, S. 2002, A&A, 385, L14
Gratton, R. G., Bonifacio, P., Bragaglia, A., et al. 2001, A&A, 369, 87

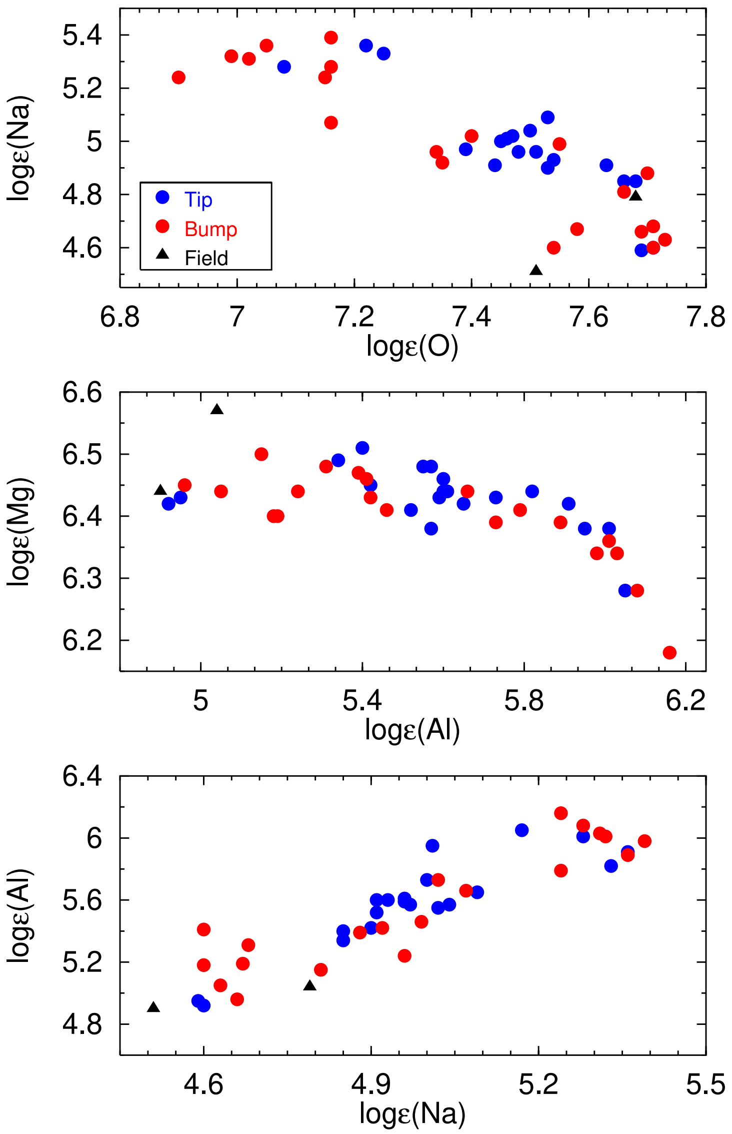


Fig. 1.1. Observed correlations and anticorrelations for elemental abundances. The Grundahl et al. (2002) RGB bump stars are included. Note how the comparison field stars fall at the high O, low Na, high Mg, and low Al end of the distribution defined by the red giants.

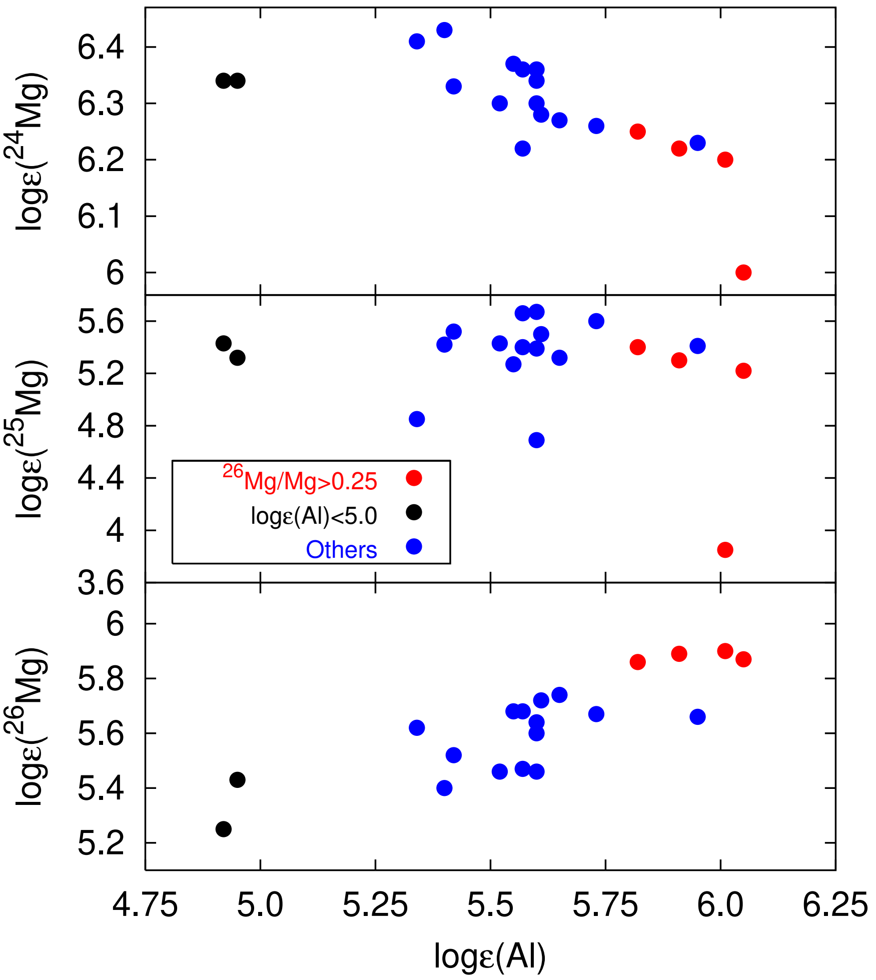
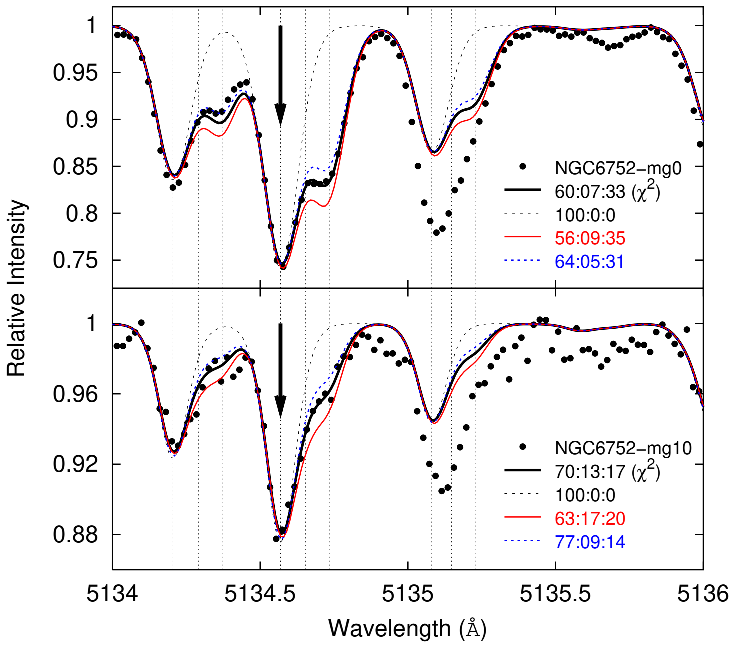


Fig. 1.2. The abundances of ^{24,25,26}Mg versus Al. ^{24}Mg is anticorrelated with Al, ^{25}Mg shows no correlation with Al, ^{26}Mg is correlated with Al.



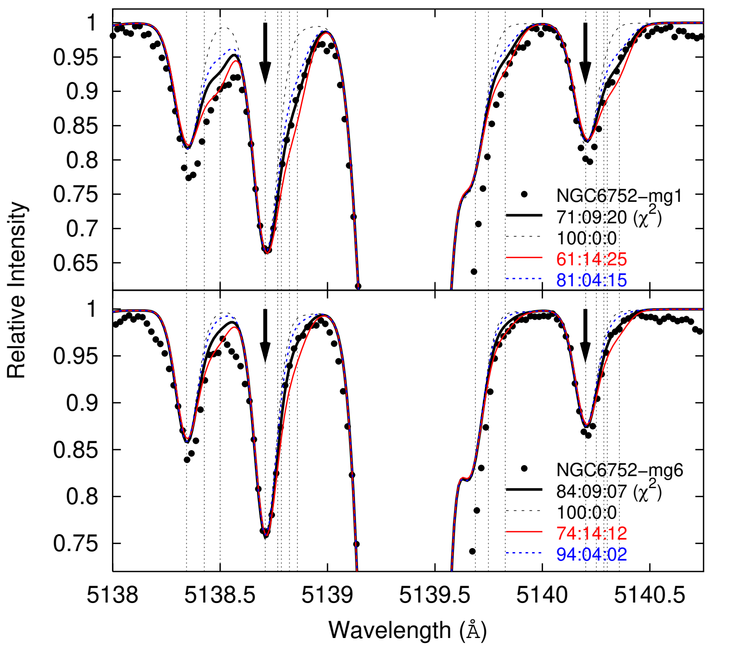


Fig. 1.3. Synthetic spectra fits to the data for different isotopic ratios ^{24}Mg:^{25}Mg:^{26}Mg. The best fit was determined by χ^2 analysis and unsatisfactory ratios are also plotted. The lines from which we determine the Mg isotopic ratio are highlighted by arrows.

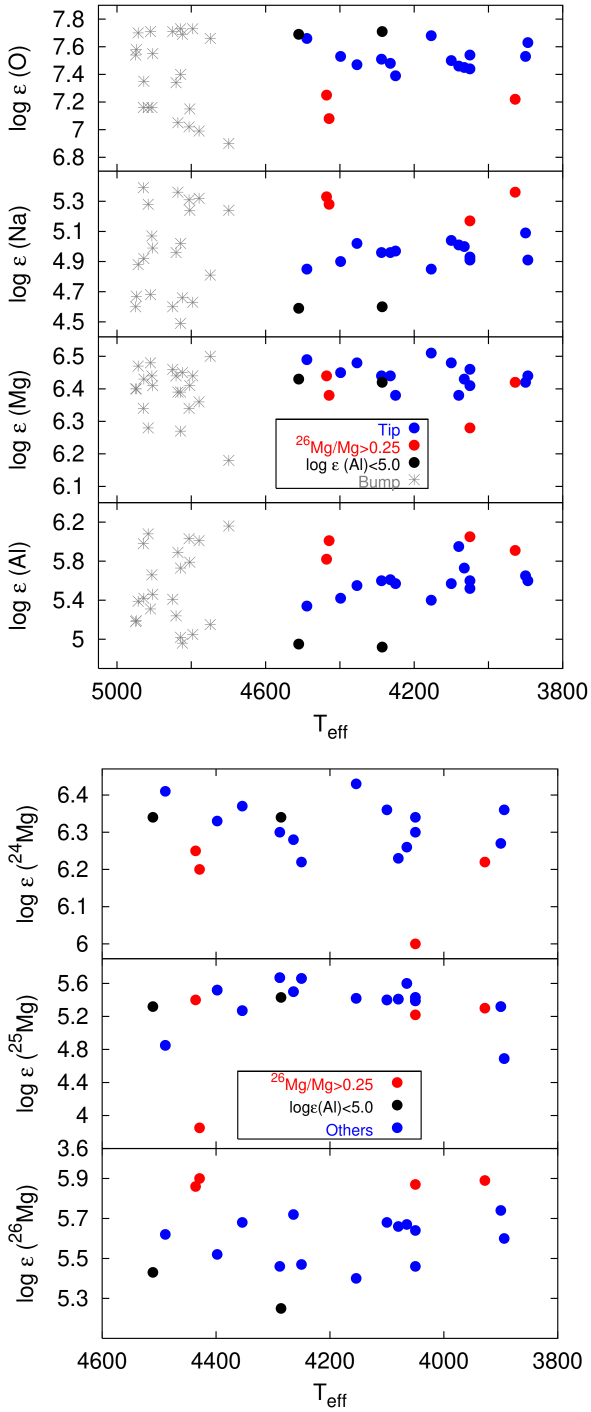


Fig. 1.4. Elemental and isotopic abundances versus T_{eff}. None of the elemental or isotopic abundances show a dependence upon evolutionary status (i.e. T_{eff}).