Chlorine Abundances in Cool Stars

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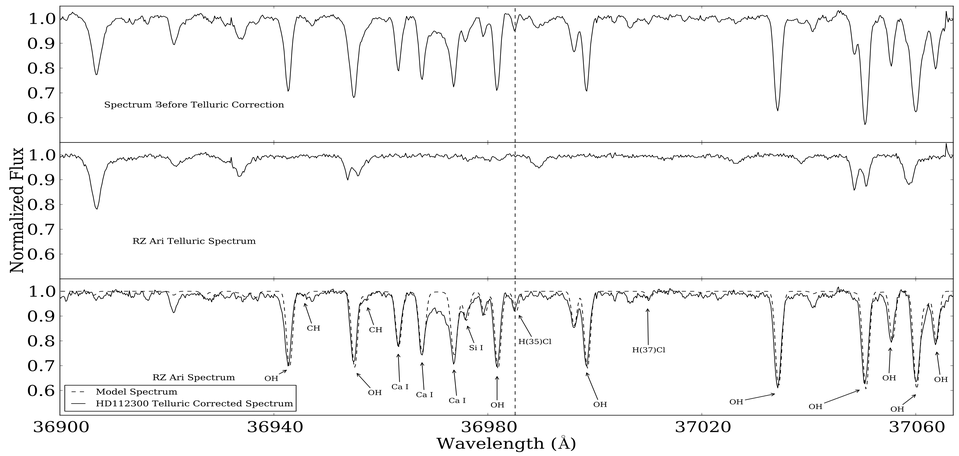
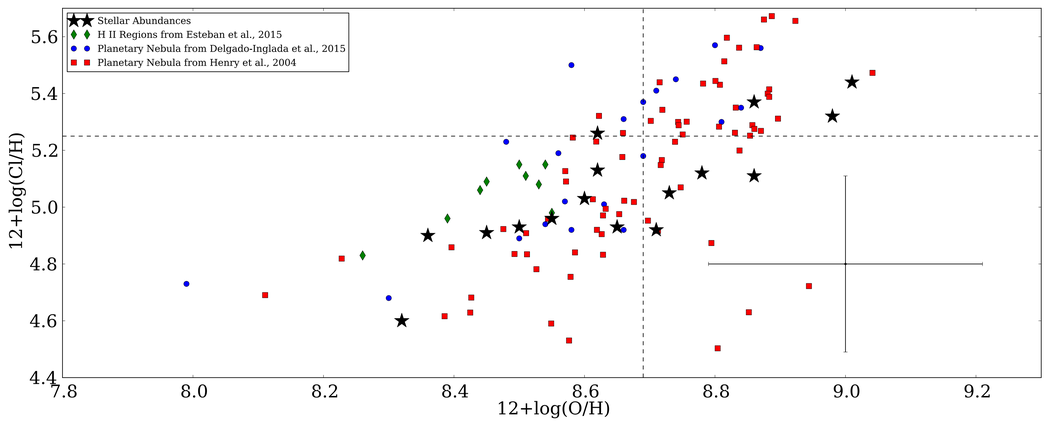
What Did We Observe?

We measured the chlorine abundance in 15 evolved giants and one M dwarf in the solar neighborhood. Chlorine is thought to be primarily produced in explosive oxygen burning, but stellar chlorine abundances are virtually unknown. High resolution L-Band spectra were obtained using the Phoenix infrared spectrometer on the Kitt Peak National Observatory Mayall 4m telescope. The Cl abundance was determined by fitting synthetic spectra to an $H^{35}Cl$ feature at 3.69 microns.



The Spectra

Fig 1: The spectrum of RZ Ari at 3.7 microns. The dashed vertical line in each image indicates the location of the $H^{35}Cl$ absorption feature. Top Panel: The spectrum of RZ Ari before telluric correction Middle Panel: The telluric contamination in this spectrum. Bottom Panel: The final spectrum after telluric removal. Labels for prominent absorption features have been added. Dashed line in bottom panel shows fit to spectrum.



Cl in Stars, HII Regions and Planetary Nebula

Fig 2: The black stars are data from our sample, the red squares are planetary nebula (PN) abundances from Henry et al. 2004, blue circles are PN abundances from Delgado-Inglada et al. 2015, and the green triangles are abundances in HII regions from Esteben et al. 2015. Abundances are measured as log(X/H) + 12. The dashed lines are solar abundances and the error bars are the average errors on our data.

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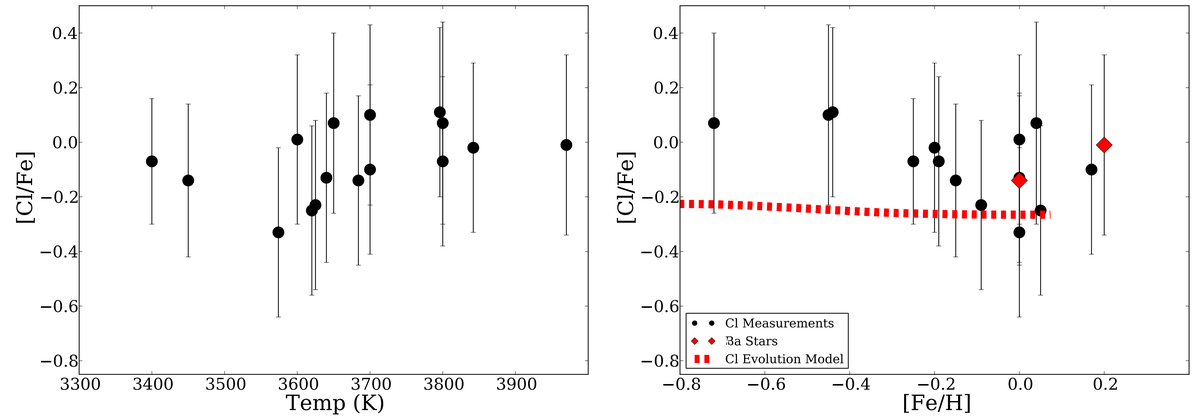
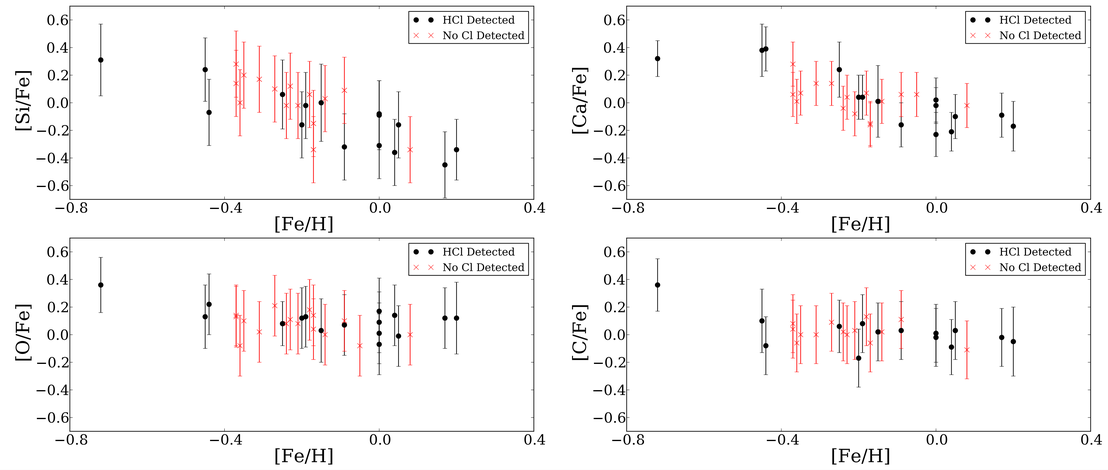


Cl in the Solar Neighborhood

Fig 3: Right Panel: The Cl abundances show no trend with their effective temperature. Left Panel: [Cl/Fe] abundances are plotted with a chemical evolution model (red dashed line) from Kobayashi et al. 2011. The red diamonds represent Ba rich stars.



C, O, Si, and Ca vs. Fe Abundance Trends

Fig 4: Each panel shows [X/Fe] for C, O, Si, and Ca measured from our spectra. Abundances of other light elements in stars with measured Cl abundances (black points) match other stars too warm to form $H^{35}Cl$ (red points) in our sample.

Conclusions

1) The $H^{35}Cl$ feature was present in stars with photospheres cooler than 3900K.
2) Absolute luminosities were calculated from Hipparcos parallax measurements and 2MASS photometry. The red giants in our sample are between 1-3 solar masses.
3) Chlorine versus oxygen abundances were consistent with abundances measured in planetary nebula and HII regions (Fig. 2).
4) Our average chlorine abundance is [Cl/Fe]= –0.07 ± 0.13. Our results are mostly consistent with chemical evolution models from Kobayashi et al. 2011, but the [Cl/Fe] ratio is slightly higher than model predictions and there is a slight decrease in [Cl/Fe] for larger [Fe/H] (Fig. 3).
5) A $^{35}Cl/^{37}Cl$ ratio of 2.2 ± 0.4 was measured in the coolest star in our sample RZ Ari (3350K).
6) C, O, Si, K, and Ca abundances were measured in our spectra. Their abundance trends and values are consistent with abundances found in similar giants (Fig 4.)

References

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