HD119608: A Rapid Rotating Hot Post-Asymptotic Giant Branch Star

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Abstract: In this study, I report a detailed abundance analysis of a rapid rotating helium rich super-giant HD119608 (in preperation; Şahin 2012).

1. Observations and analysis

High resolution (0.05 A/pixel) optical spectra were obtained in two different runs on the nights 1999 July 28, and 29 with the 3.9-m Anglo-Australian Telescope (AAT). The UCLES (Walker & Diego 1985), giving a spectral coverage from 3847 to 5010 A, with central wavelengths of 4307 A and 6043 A (4915 to 8150 A), was employed. Wavelength residual for Th-Ar exposure was less than 0.01 A, (see Şahin 2012 for details).

A grid of twenty-four model spectra was calculated with Teff =15,000, 18,000, 20,000, 22,000, 24,000, and 25,000 K ,logg = 2.5 (0.5) 4.0, and nHe = 0.10 in the range of 3900 – 5010 A. STERNE computed solar metalicity models were used. Model atmosphere parameters were obtained with SFIT2, a general-purpose code designed to optimize theoretical stellar spectra to an observed spectrum, were Teff =23,300 K, and logg = 3.0 and errors in model atmosphere parameters are ±500 K and ±0.1 dex respectively. Best model fit (in green) was presented in Figure 1 and 2 with TIGER (Şahin 2008; see the poster) normalized spectrum of the star. Abundances calculated by the best fit model are presented in Table 1. The metallicity ([Fe/H]) of the star was calculated from Fe abundance and was found to be [Fe/H]~0 (solar). Several ions including Si III triplet around 4550 A (multiplet no.2) gave a micro-turbulent velocity vt of 6±1 \kmsec which was used in calculation of the best fit model.

The rotational velocity of the star was found to be vsini = 55±1 km/sec by using C, O, N, Al, and Fe lines. As a consistency check, the Si III triplet multiplet no.9 around 4810 A, where normalization related effects were minimum, was used. It agreed with the above value.

The radial velocity of the star was measured by using C, N, O, Al, Si, and Fe lines. While Al, Si, P, and Fe lines gave vr=57 \kmsec, C, N, and O lines gave 53, 49, and 52 km/sec respectively. The mean radial velocity was vr =55±1. The vr value for the Fe lines, vr = 57±1, was used in the best model fit.

The heliocentric correction for the date of observation was found to be +29 km/sec.

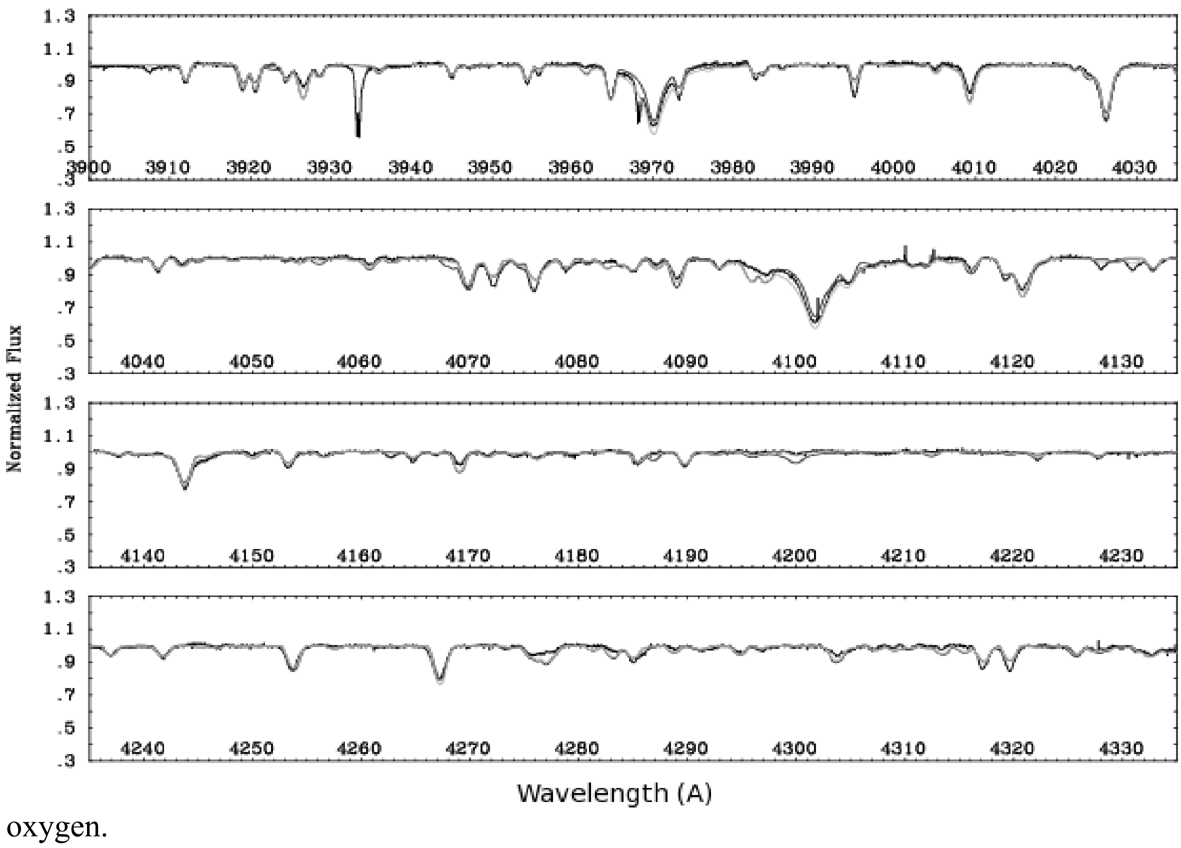
Elements	H	He	C	N	O	Mg	Al	Si	P	S	Fe
($T_{\rm eff}$, $\log g$)											
(23 000,3.0)	12	11.24	8.41	8.03	8.72	7.99	6.30	7.50	5.24	7.11	7.66
±		0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.04	0.02	0.01
(26 000,3.0)	12	11.68	8.72	8.53	9.09	8.62	6.90	7.55	5.24	7.40	8.30
±		0.01	0.01	0.01	0.01	0.03	0.02	0.02	–	0.02	0.01
SUN	12.00	11.00	8.52	7.92	8.83	7.58	6.47	7.55	5.45	7.33	7.50

Table-1: Photospheric chemical abundances of HD119608 for two model fits of Teff =23,000 K (best fit) and Teff =26,000 K given as logn and compared to solar abundances (Grevesse & Sauval 1998).

2. Photometric vs. spectroscopic Teff

While the methods based on B-V colour of the star gave a photometric temperature of 23,000 K ,others based on Strömgen indices gave 26,000 K. Our model atmosphere analysis shows that HD119608 has a temperature of 23,000 K. It should be noted this temperature seems to be in agreement with Conlon (1992), who gave 24,000 K. In order to explain this discrepancy on the basis of chemical abundances, we computed a model atmosphere with Teff = 26,000 K and logg = 3.0 with the same vt and vsini being 6 and 55 \kmsec respectively. The best model fits for both 23,000 K , and 26,000 K ,temperatures are presented in the Figure 1 and 2. As can be seen from the figures, most of the regions in the spectrum match except the Balmer lines.

The wings of the Si,III triplets at 4550 A are fitted well by both models however cores are not filled up. Hence, the silicon abundance was determined from silicon triplet multiplet no.9 which is fitted well with the 23,000 K ,model atmosphere (see Şahin 2012 for details; in preperation). The [4625-4720] region is dominated by blend features of carbon and



oxygen.

Figure-1: Two model fits of Teff = 23,000 K (in green) and Teff =26,000 K (in red) are presented. Both model and observed spectra are moved to zero velocity reference frame - I.

3. On rapid rotation and binarity

A heliocentric velocity of -28 km/sec was reported by Martin (2004) and this value is significantly different from the value of 26 km/sec listed in SIMBAD. Our analysis gave 28 km/sec which is in agreement with the other published measurements in the literature. The difference in the radial velocity might be indicating to a binary nature of the star. This might be also an explanation for the observed discrepancy in abundances (e.g. [He]) for some elements in the spectrum. The spectrum of the star is tested by both spectrosocopic and photometric temperatures. Both high and low temperature model atmosphere fits are not presenting the observed spectrum of this rapidly rotating star perfectly. This could be understood if star had a companion.

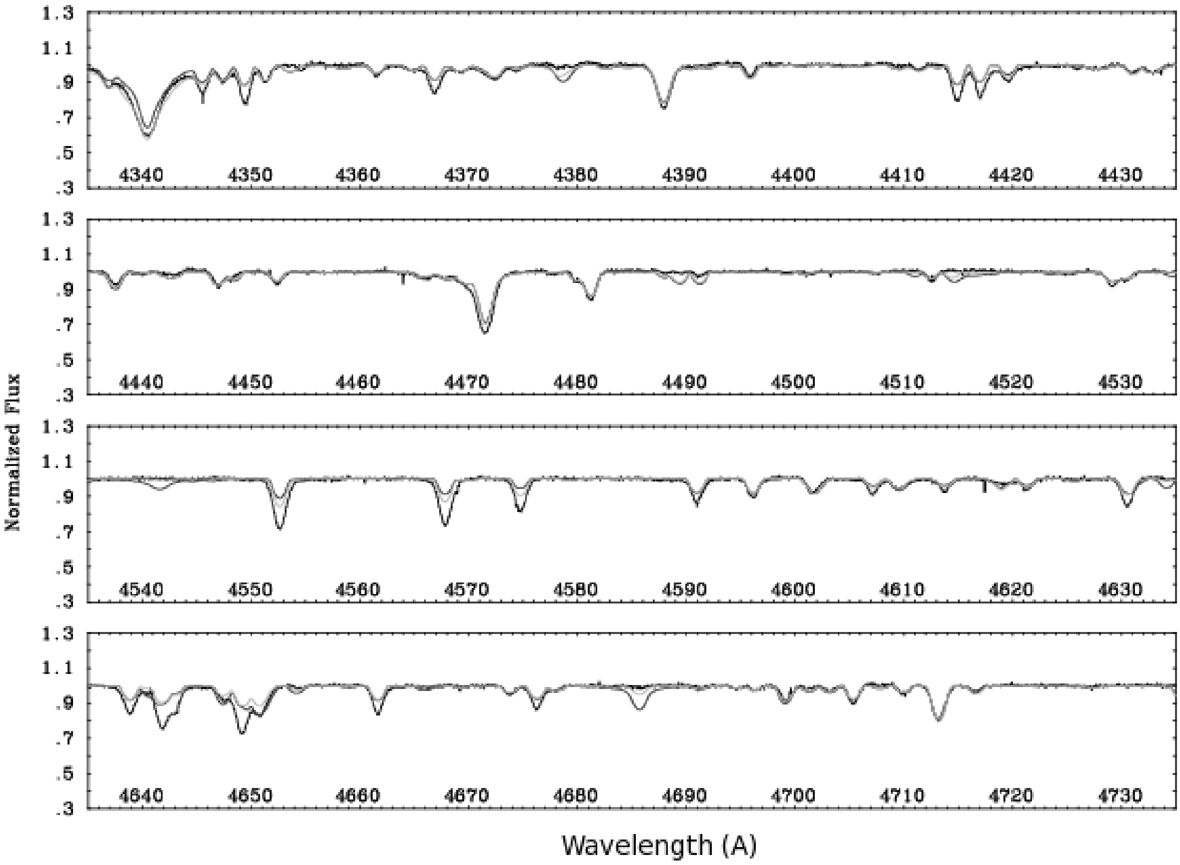


Figure-2: Two model fits of Teff = 23,000 K (in green) and Teff =26,000 K (in red) are presented. Both model and observed spectra are moved to zero velocity reference frame - II.

4. Discussion

Evolutionary status of the object - Generally speaking, in terms of quality of the fits, we have two different temperature models which can not be easily distinguished visually (by eye). The more rational way of differentiating these two models would be making this comparison in terms of chemical abundances which draw two different picture from evolutionary point of view for the star.

Both model atmospheres give almost solar carbon abundance if we estimate the error in the abundances due to the adopted model atmosphere parameters as 0.3 dex which was used as step size in grid interpolation during optimization of the best model fit. On the other hand, while the 23,000 K model gave a solar nitrogen abundance, the 26,000 K model indicated to an overabundance in this element (~0.6 dex). In the same way, silicon and sulfur abundances seem to be normal for both models. Mg shows overabundancy (~1 dex) in 26,000 K model. Sulfur was slightly deficient in the 23,000 K model while Al and Fe found to be overabundant in the 26,000 K model.

When metalicities are compared, the 23,000 K , model indicates a solar metallicity. The 26,000 K model gives a metal-rich composition. Adopting the former model implies that photospheric abundances do not indicate a CNO processed surface (which is accounted for an overabundancy in nitrogen at expense of carbon). It does not show helium enriched surface composition either and carbon is solar. We did not observe any s-process element in the star.

We estimated the mass of the star as 0.598 Msolar from post-AGB evolutionary tracks of Schönberner (1983, 1987). The gravity is converted to a radius of Rsolar which in turn gave log L/L ~3.6 with Teff from our model atmosphere analysis. This luminosity is typical for a post-AGB star.

In contrast to above model atmosphere results, a high metallicity does not match with the star's current evolutionary state. So that we believe that our model atmosphere parameters represent the observed optical spectrum best.

5. References

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