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Fitting of Silicon lines in UV and Balmer Hδ Line in Optical Spectra of B supergiant HD 198478

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Abstract. Atmospheric parameters of the Galactic early B-supergiant HD 198478 (55 Cyg) were determined from the UV silicon lines and optical Balmer Hδ 4101 Å line. TLUSTY synthetic spectra were broadened using the ROTIN numerical code in order to determine effective temperature, surface gravity, rotational and macroturbulent velocity.

Keywords. line: profiles, stars: fundamental parameters, stars: supergiants

1. Introduction

Massive B supergiants (BSGs) are mostly investigated in the optical region, while UV spectra have been avoided as this region is dominated by a vast number of spectral lines which make spectral analysis very difficult. HD 198478 is a well known early BSG, subject to numerous studies mainly in the optical region (Crowther *et al.* 2006, Markova & Puls 2008, Searle *et al.* 2008). We have chosen this object as a probe star from a large sample of galactic BSGs. Our aim is to establish a consistent method for determination of atmospheric parameters from International Ultraviolet Explorer (IUE) spectra of BSGs, as IUE is in many cases the only source of UV spectra of these stars.

2. Observations and methods

We have identified and used UV Si III multiplet lines at 1294 Å, 1299 Å, 1301 Å and 1303 Å, Si II doublet lines at 1264 Å and 1309 Å, Si III singlet lines at 1312 Å and 1417 Å, and the optical Balmer Hδ 4101 Å line. High-resolution UV spectra were obtained by IUE between 1200 Å and 1450 Å with a resolution of 0.16 Å at 1400 Å, as well as by the more recent HST STIS in the range 1150-1360 Å with a resolution of 0.012 Å. High-quality optical spectra from 4100 Å to 4900 Å with a resolution of 0.4 Å were obtained by Markova & Puls (2008). Atmospheric parameters of HD 198478 were determined by line profile fitting of the observed spectra with the available BSTAR grid model spectra obtained by TLUSTY and SYNSPEC (Lanz & Hubeny 2003, Lanz & Hubeny 2007) numerical codes. Synthetic spectra were broadened with instrumental profiles, and rotational and macroturbulent velocities by using the ROTIN code. Following Markova & Puls (2008) and Monteverde *et al.* (2000), we have adopted the TLUSTY grid with Si abundance od 7.55. In order to reduce the number of free fitting parameters, we used the TLUSTY grid value with a microturbulence of 10 km/s in accordance with McErlean *et al.* (1999). After determination of log g from the Hδ line, silicon UV lines were fitted with effective temperature, macroturbulent and projected rotational velocities as free parameters.

Table 1. Atmospheric parameters od HD 198478 determined by different authors.

Author	T_{eff} (K)	Log g	v_{tot} (km/s)
Crowther *et al.* (2006)	16500	2.15	61
Markova & Puls (2008)	17500	2.10	66
Searle *et al.* (2008)	17500	2.25	61
Jurkić *et al.* (2011)	17000	2.25	62

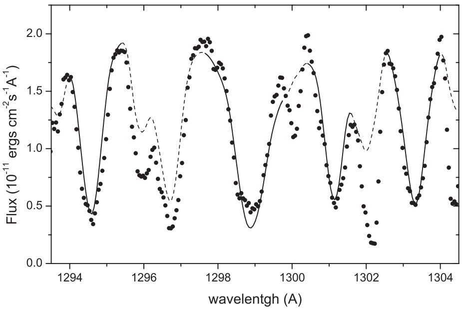

Figure 1. Observed IUE and synthetic spectra for Si III 1294-1303 Å multiplet lines. Only parts of the spectra unambiguously belonging to the spectral lines are fitted (full line).

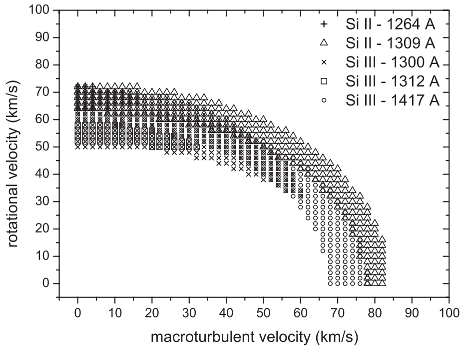

Figure 2. Plot of the pairs (v_{macro}, v_{rot}) that produces acceptable fits for all measured silicon lines.

3. Discussion

There is a very good agreement of our results with the results of other authors, which were mainly obtained from the optical spectra by use of plane-parallel or wind models (Table 1). Our analysis shows that the plane-parallel TLUSTY atmosphere model, despite the fact that it does not include wind effects, can successfully reproduce Si line profiles and determine atmosphere parameters. Note that Searle *et al.* (2008) failed to reproduce UV spectra of photospheric silicon lines using the CMFGEN wind model.

Our results have shown that the line broadening cannot be explained by the rotational velocity only, but that an additional macroturbulent velocity component should be taken into account, with a significant degeneracy between macroturbulent and projected rotational velocities (Fig. 2). Comparison between the IUE UV spectra and the HST STIS spectra of higher quality have shown that IUE spectra can be used for modeling the stellar atmosphere in the UV (Fig. 1). We can conclude that the Si lines are photospheric and unaffected by the stellar wind, suggesting that line-blanketing, line-blocking, and detailed treatment of ionization levels as found in TLUSTY are essential in treating photospheric UV lines.

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